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Regenerating Longleaf Pine Naturally

Thomas C. Croker, Jr.
and
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Seeded under a moderate overstory in 1947 and released by a removal cut in 1954, this stand first alerted foresters at Brewton to possibilities for shelterwood management of longleaf pine. In 1974, 21 seasons after release, many dominants exceeded 8 inches in

Regenerating Longleaf Pine Naturally

Thomas C. Croker, Jr., and William D. Boyer

Inherently the most valuable pine of the South, longleaf has been widely replaced by other species that reproduce more successfully. Research over the past two decades, however, provides guides for consistent natural regeneration by a shelterwood system. Key measures of the recommended system include hardwood control by fire and other means during the rotation, timely preparatory and seed cuts, seed crop monitoring, seedbed preparation by fire or mechanical means, protection of established seedlings, prompt removal of parent trees when stocking of reproduction is adequate, and control of competition and brown-spot disease after the removal cut.

Establishing the new crop primarily from the first 20 percent of seedlings emerging from the grass stage maximizes growth rates and tends to preserve inherited vigor and resistance to brown spot.

Additional keywords: *Pinus palustris,* shelterwood, prescribed burning, timber management systems.

Reduction of the longleaf pine (*Pinus palustris* Mill.) forests from an estimated 60 million acres in colonial times (Wahlenberg 1946) to less than 15 million acres today is in large part a reflection of regeneration failures. Old-growth longleaf provided the choicest timber of the southern pines. The second-growth is similarly straight, clear, and free from defect. Users, especially of poles and piling, generally prefer it to other pines. It is resistant to fire and most insects and diseases. Many foresters and landowners interested in a multi-product, multiple-use forest prefer longleaf pine.

Harvesters of old-growth timber appreciated the superior qualities of this tree but rarely attempted to reproduce it. Grass, or stands of hardwoods, loblolly pine (*P. taeda* L.), and slash pine (*P. elliottii* Engelm.) took over many sites after the longleaf was cut. On extensive areas and usually by accident, good second-growth stands did become established. Except for limited plantings and direct seedings of recent decades, these fortuitous reseedings provided today's commercial longleaf pine forests.

Most of the second-growth longleaf will reach maturity and will need to be harvested and regenerated by the year 2000. Seeding or planting following mechanical site preparation can establish new stands, and is necessary where parent tree stocking is low or competition is excessive. Where feasible, however, natural regeneration offers substantial advantages.

Natural regeneration does not require purchase of seed, and costs less for manpower and for equipment operation. Less nonrenewable resources such as fossil fuels are needed. Large cash expenditures are unnecessary. During the regeneration period much high-grade wood can be grown on large, well-spaced trees retained as seed bearers. Retaining a partial stand while regeneration is being established is aesthetically and environmentally preferable to clearcutting and incurs less risk of soil erosion. Selection of high-quality seed bearers also preserves a diverse pool of desirable genotypes.

Desirable in theory, natural regeneration of longleaf pine proved difficult in practice. Biological and environmental factors, as well as genetic traits of the species, presented major obstacles. Until recently, therefore, deliberate natural regeneration was seldom attempted.

Beginning in the 1920's, research concentrated on planting grass-covered stumplands which then occupied millions of acres of former longleaf type. Two decades later [illegible] which culminated in effective direct seeding.

Drawing in part on these studies, researchers at Brewton, Alabama, and elsewhere developed information on which to base a shelterwood system for obtaining natural regeneration consistently and [illegible]

ENVIRONMENT AND SILVICS

The most important single factor in longleaf silviculture is the species' unique adaptation to an environment where surface fires are frequent. Longleaf is native to most of the Gulf and Atlantic Coastal Plains from North Carolina to eastern Texas, with extensions into the Piedmont and Southern Appalachian regions. Its original range was probably similar to the present commercial range (fig. 1), but the acreage it occupies is greatly reduced.

Soils within the range are typically sandy, infertile, and acid. Though rainfall averages 40 to 60 inches annually, seedling losses to drought are frequent, especially on the coarse sands of western Florida and the sandhills of Georgia and the Carolinas. Topography is generally flat to rolling, with broad uplands broken occasionally by drainages wide enough to be barriers to fire. Originally, longleaf pine forests dominated the uplands, hardwoods the main river floodplains, and mixtures mainly of hardwoods and loblolly or slash pines the minor drainageways and other moist sites.

Fire Subclimax Type

Longleaf, like most other southern pines, is classified as a subclimax species, because in the absence of disturbance it eventually is replaced by more tolerant trees. Fire is one of the important disturbers and is almost requisite to perpetuation of longleaf under natural conditions. Without frequent fires, hardwoods would dominate understories or, with other pines, would outgrow longleaf seedlings (fig. 2). Ecologists have therefore interpreted the longleaf pine type as a "fire sub-climax" (Wells and Shunk 1931, Weaver and Clements 1938, Oosting 1956).

Longleaf pine's dependence on fire derives from differences in traits between it and its competitors. Hardwoods have higher photosynthetic rates in shade than pines (Kozlowski 1949, Kramer and Decker 1944). Both pine and hardwood competitors grow continuously in height while longleaf remains in a grass stage for several years. Over a rotation, prescribed burns are usually needed to control hardwood understories. During regeneration, fire and other measures are used at times when they reduce competition

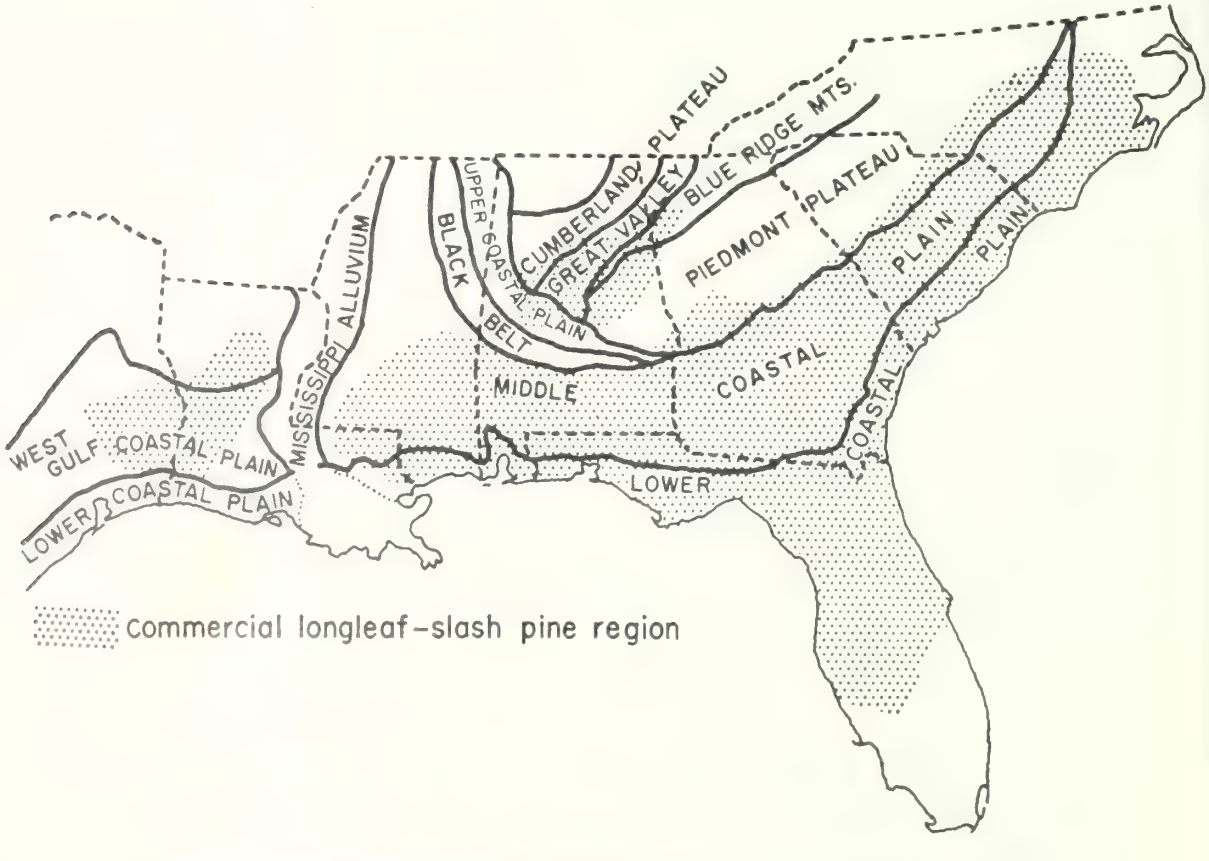

Figure 1. *Commercial range of longleaf pine and major physiographic provinces.*

Figure 2.—*Without fires to control them, hardwoods may dominate regeneration areas and permanently suppress grass-stage seedlings.*

from grass and brush or control disease with minimal damage to the longleaf seedlings.

Seed Supply

A major regeneration problem is irregular seed production. Wahlenberg (1946) reported good seed crops at 5- to 7-year intervals, failures 1 year out of 5, but many exceptions to this periodicity. Maki (1952) noted that during a 20-year period after 1930 there were nine medium or better seed crops and 14 light or better crops in south Mississippi. Although these early records are observational, the "good" and "medium" estimates may approximate the frequency of crops adequate for regeneration.

On the Escambia Experimental Forest in south Alabama, seedfall has been measured by trapping since 1955. Results are shown in table 1. During a 19-year period, shelterwood stands produced five crops of 50,000 or more seeds per

Table 1.—*Longleaf* [illegible] *Experimental Forest, 1955-1973*

Year	Shelterwood stands[1]	Seed-tree stands[2]
1955	104	20
1956	Neglig.	Neglig.
1957	6	3
1958	27	24
1959	4	4
1960	33	21
1961	69	46
1962	4	4
1963	Neglig.	Neglig.
1964	23	4
1965	1	1
1966	Neglig.	Neglig.
1967	122	56
1968	34	5
1969	5	2
1970	1	1
1971	63	6
1972	2	Neglig.
1973	69	2
Mean	29.8	11.0

[1] Density of seed bearers per acre averaged about 30 square feet of basal area.

[2] Density of seed bearers per acre averaged about 10 square feet of basal area.

acre—an average of one every 4 years. Crops of this size usually provide a satisfactory stand of seedlings with no more site preparation than a burn.

Under seed trees the count was much less. In the 19 years there was only one crop of 50,000 seeds or more.

Development of longleaf pine seeds is a hazardous process extending into 3 calendar years. Standard terminology for female strobilus stages, as proposed by Croker (1971a), is as follows:

Year and stage	*Usual start*	*Description*
Bud year		
Bud	July, second calendar year before seed year	Primordia visible under magnification
Flower year		
Flower	March	[illegible]
Conelet, early	June	Flower scales closed
Conelet, late	October	[illegible]
Seed year		
Cone green	[illegible]	Specific gravity 1.0 [illegible]
Cone ripe	October, late September	[illegible]
Cone open	[illegible]	[illegible]

Matthews (1932) and others have described seed development in detail. The reproductive primordia are differentiated usually about the summer of the bud year, and the buds of male flowers begin to appear in December of that year. Female strobili usually appear in March of the flower year; the date ranges from mid-February to early April, depending on temperatures. Pollination follows immediately, but fertilization is delayed until early in the seed year, when the female strobili are still in the late conelet stage (fig. 3). After fertilization the strobili enter the green cone stage, and growth is rapid until early October when the cones are ripe.

Shoulders (1967) has shown that abundant rain in the spring and early summer of the bud year improves flower production. A severe freeze during the flower stage can do severe damage. On the Escambia Experimental Forest, entire flower crops have been destroyed by March frosts. Boyer (1974a) reported that cone production is strongly correlated with pollen density during the flowering period and that female strobili may abort if pollination is inadequate.

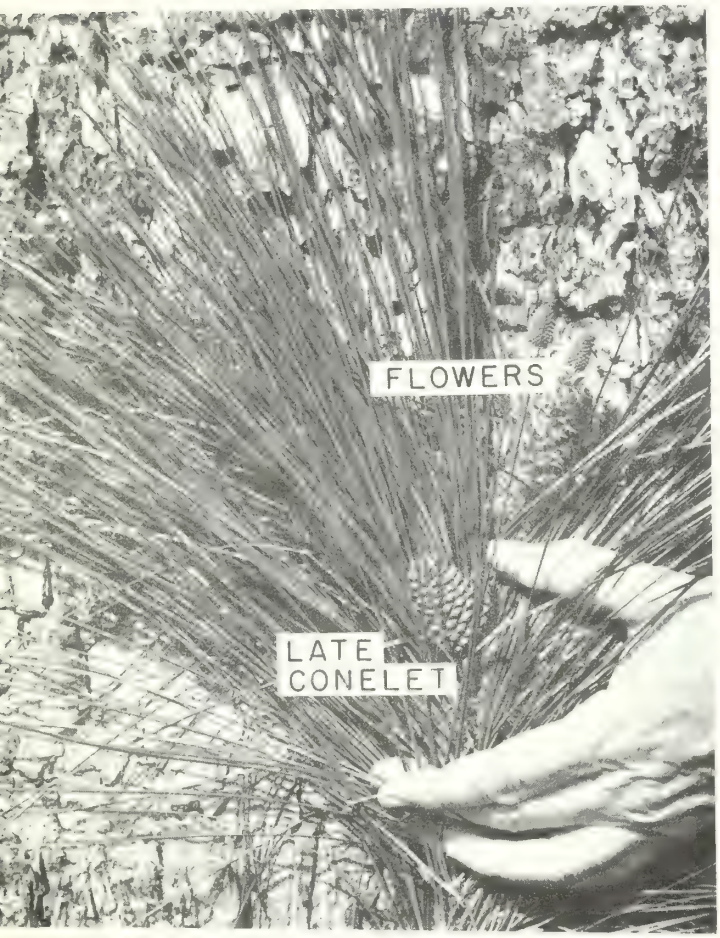

Figure 3.—*Pistillate flowers usually appear in February or March of the flower year; seeds are not mature until October of the seed year, 20 months later.*

The number of seeds per cone varies greatly. Croker (1973) found that the count averaged 50 in a good year, 35 in an average year, and 15 in a poor year.

Insects and disease can decimate promising seed crops; DeBarr (1967) noted that seed bugs (*Tetyra bipunctata* [H.-S.] and *Leptoglossus corculus* [Say]) cause much of this damage by feeding on the seed.

Dispersal starts in late October. Most seeds are down by the end of November, although a few may fall as late as the following February. The flight range is short. According to Boyer (1958, 1963b), the amount of sound seed deposited is halved with each additional ½-chain distance from a wall of timber. Effective seeding distance is usually not more than 100 feet. Viability also decreases sharply with distance, because empty seeds carry further.

Generally seed production is greatest on good sites (Croker 1973). Trees that have well formed crowns and are over 30 years old and at least 10 inches in d.b.h. usually are the most prolific. Production increases with diameter up to about 15 inches d.b.h. Some trees are inherently more fruitful than their neighbors (Allen 1953, Croker 1964, Shoulders 1967), regardless of morphological characteristics.

In studies of seven seed crops, Croker (1973) found that cone production declined with increasing stand basal area in excess of 30 square feet per acre. Other studies at the Escambia Experimental Forest have indicated that 30 square feet may be close to optimum, as decreases were observed at lower as well as higher densities (fig. 4). Cones per tree generally increased with declining basal areas, but the reduction in number of seed trees lessened the numbers of cones per acre.

When a stand is ready for regeneration, therefore, a seed cut should be made to reduce it to about 30 square feet per acre of seed bearers. This cut should be made well in advance, since cone crops will not benefit fully until at least three growing seasons after release. In the 1951 crop, for example, trees released during the bud year produced 61 cones apiece, those released

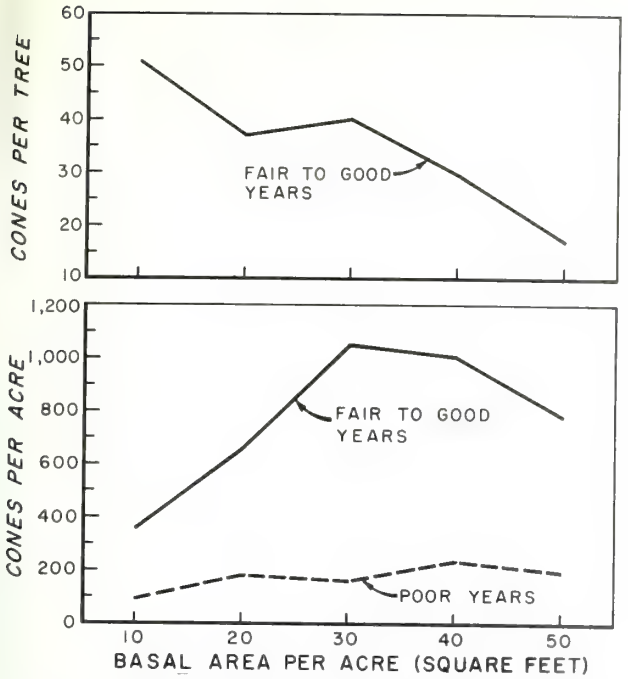

Figure 4.—*Longleaf pine cone production per tree and per acre, as affected by stand density (based on Escambia Experimental Forest records).*

during the flower year 28 cones, and those released during the seed year 16 cones (Croker 1952).

Germination and Establishment

Unlike those of other southern pines, longleaf seeds germinate soon after dispersal in the fall. This habit reduces the period of vulnerability to predators like birds, mice, squirrels, and ants (Boyer 1964b; Stephenson, Goodrum, and Packard 1963). On the other hand, the cotyledonary seedlings are subject to freezing temperatures or frost heaving (Croker 1968) as well as to desiccation or high temperatures during droughts in late autumn. They are also exposed to destruction by grazing animals (Boyer 1967) and to clipping by rabbits (Campbell 1971).

The seeds require contact with mineral soil for germination and establishment, and they cannot tolerate flooding. Since the large wing prevents them from penetrating heavy grass or litter, burning or mechanical measures to remove such barriers are essential (Chapman 1946; Croker 1957, 1975; Morris and Mills 1948; Smith 1961a).

Tree percents (number of established seedlings per 100 seeds) are generally highest in good to excellent seed years (Gemmer, Maki, and Chapman 1940).

Survival and Growth

Survival and growth are closely related to longleaf's two unique silvical characteristics: its well-known grass stage and its high resistance to fire. The grass stage usually lasts for 4 or 5 years after the seedlings are released from the overstory but may range from 1 to 20 years; during it, the young trees make no height growth. If reproduction of competing species—hardwood or pine—is allowed to grow freely it will completely dominate the site while longleaf seedlings are in the grass. Once this has occurred, the longleaf stand can never regain dominance.

While in the grass stage, longleaf may be killed by hogs (Hopkins 1947, Peevy 1953) and damaged by heavy cattle grazing (Boyer 1967). It also is most vulnerable to its major disease, brown-spot blight, caused by *Scirrhia acicola* (Dearn.) Siggers. The infection prolongs the grass stage and kills many seedlings (Siggers 1944). Under certain conditions fire can be used for control (Croker 1967, Wakeley and Muntz 1947). A parent-tree overstory of medium or high density also tends to inhibit brown spot (Boyer 1963a, 1975).

Causes of the grass-stage habit are not completely known (Allen 1964, Brown 1964), but competition and site are important factors (Bruce 1951b, Croker 1959, Pessin 1944, Walker 1954).

Individual seedlings tend to express dominance early in life, even in the grass stage. This is a desirable trait, tending to prevent stagnation in dense stands. The seedling-to-seedling variation in growth may be genetically controlled. Derr (1963), for example, reports strains that are highly resistant to brown spot and make fast height growth (Snyder 1973). Studies by Boyer (1972) and Wakeley (1970) also suggest that wild populations include brown-spot resistant individuals that develop early dominance. Cultural practices should aim at selecting crop trees from this desirable and perhaps genetically superior portion of the local population.

Longleaf pine is adapted to withstand fire by thick bark on its lower stem and by its unusual habit of growth. Though vulnerable in their first year or two, seedlings soon develop a large, relatively insulated terminal bud. A groundline diameter of 0.3 inch can be taken as the size at which grass stage [illegible] ant (Bruce 1951a, 1954). Immediately after

height growth begins, the trees are again susceptible, especially those heavily diseased (Maple 1975). They usually gain height rapidly, however, and after they are 3 feet or taller a light fire does little harm.

Mortality of grass-stage seedlings from prescribed fires in Alabama tests is shown in figure 5. Mortality was higher among unreleased than among released seedlings of equal diameter, partly because the pine needles under the overstory supported hotter fires than did the grass on released areas. Brown spot, excessive competition, and any other factors that impede seedling growth may seriously prolong the period of initial vulnerability.

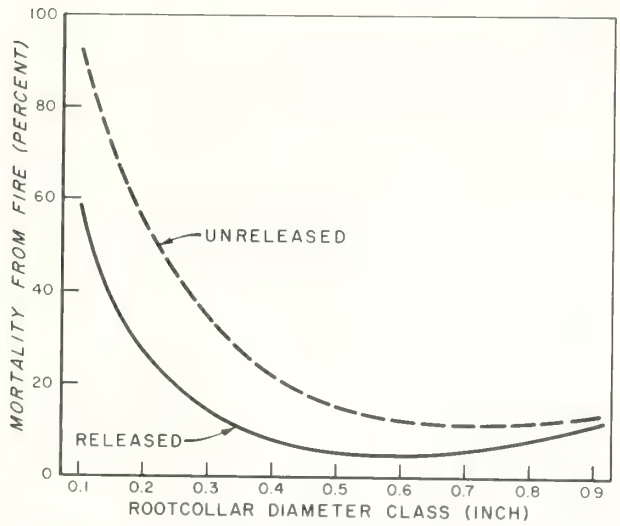

Figure 5.—*Fire kill in relation to size of released and unreleased longleaf pine seedlings. Mortality in the 0.9-inch class may reflect losses of seedlings beginning height growth, which are vulnerable while under 3 feet tall (based on Boyer 1974b).*

The seedlings are highly susceptible to root competition. Growth under full pine or hardwood overstories averages only about half that achieved in the open (Boyer 1963a, 1976). Suppression by parent trees extends well beyond the crowns, an indication that root competition has a greater impact on seedling growth than overstory shade.

Most seedlings can survive under pines or hardwoods for 7 to 10 years (Boyer 1963a, Smith 1961b) and respond well when the overstory is removed (Boyer 1976). Poor timing of fires rather than competition causes excessive mortality of grass-stage seedlings under an overstory. In the absence of fire, Boyer (1974b) found that mortality under pines or hardwoods differed little from that for seedlings released from all overstory competition.

Logging damage to be expected during removal of parent-tree overstories must be considered when evaluating the adequacy of stocking. Grass-stage seedlings are more resistant to damage than those making height growth (Boyer 1964a, Croker 1956a). Logging-related mortality is least when the overstory is removed at seedling age 1 or 2 (Boyer 1974c).

REGENERATION METHODS

A method for natural regeneration of longleaf pine should afford at least four essentials: (1) sufficient desirable parent trees, so distributed that they provide an adequate supply of seed throughout the regeneration area, (2) midstory and seedbed conditions favorable for the establishment, survival, and growth of seedlings, (3) protection from hogs, wildfire, brown spot, and other hazards, and (4) complete release from overstory and brush competition after adequate stocking has been secured. In addition, it is highly desirable to maintain a well-stocked overstory until seedlings are firmly established. The overstory provides seed in case more should be needed, and it also suppresses brush and grows substantial quantities of quality timber during the regeneration period.

Of the five American methods of natural regeneration, only three—clearcutting, seed tree, and shelterwood—need be considered for longleaf pine. Longleaf does not sprout satisfactorily for coppice. Because standwise regeneration measures are essential, selection systems are impractical.

Clearcutting has critical limitations (fig. 6). Advance reproduction is usually scarce and would be destroyed in a heavy cut. Seed must then come from the side, as it is not stored in the duff and has a short dispersal range. Four requirements for success with this method are: (1) all the regeneration area must be within about 100 feet of a seed source, (2) there must be a good seed crop on the adjacent timber, (3) seedbed conditions must be favorable, and (4) predator pressure must be low. In good years, clearcutting in a groupwise manner or as progressive strips may meet these requirements. In poorer seed years, success is doubtful; brush will invade

Figure 6.—*The clearcutting method is of limited use in natural regeneration of longleaf pine. Advance reproduction, if present, is destroyed by logging or smothered by the heavy debris. Seeding from adjacent stands is effective for only about 100 feet.*

rapidly and corrective measures will be expensive.

Clearcutting followed by planting or direct seeding is being practiced, but is beyond the scope of this publication.

The seed-tree method removes from an area in one cut all the mature timber "save for a small number of seed bearers left singly or in small groups" (Ford-Robertson [ed.] 1971). Seed trees usually number three to five and rarely more than 10 per acre. In a 19-year test on the Escambia Experimental Forest (table 1), intervals between usable seed crops were longer than for shelterwood stands because the source was inadequate. Despite prescribed burns, cutting areas also reverted more rapidly to brush, since overstory competition was slight (fig. 7). Growth per acre on the reserve stand was much less than in shelterwood cutting (Croker 1956b). Occasionally, good stands have been established by this method, but the risks are high.

Because of longleaf's presumed intolerance of overhead competition, few foresters prior to 1950 considered the shelterwood method suitable. Early studies (Croker 1956b) on the Escambia Experimental Forest, however, revealed that

Figure 7.—*Over 19 years, seed-tree stands on the Escambia Experimental Forest rarely produced enough seed for adequate regeneration. [illegible] tion by the cutting.*

seedlings established under moderately heavy overstories survived a removal cut, responded promptly, and grew well (fig. 8). This finding was supported by observations elsewhere. For example, Paul Garrison, former chief forester for Gaylord Container Corporation, reported development in Louisiana of several thousand acres of good second-growth from advance reproduction under old-growth stands fortuitously clearcut and protected from fire (personal correspondence, January 1955).

Following these leads, our research since the mid-1950's has sought basic silvical knowledge and techniques needed to apply a shelterwood approach.

We have learned that good seed crops are more frequent in shelterwood than in seed-tree stands; that the overstory reduces brush encroachment primarily by increasing the effectiveness of prescribed fire; that reproduction, if protected from wildfire and grazing, can be held for 7 or more years under the shelterwood; that advance reproduction grows satisfactorily after release; that the shelterwood tends to inhibit brown spot; and that 150 to 200 board feet per acre per year of high-quality wood can be grown while the stand is being regenerated. We have also developed guides for applying treatments to utilize these potentials economically, and have demonstrated their successful application on more than 15 representative areas.

On the average, about 3.5 years have been required to establish satisfactory reproduction, with a range of 1 to 6 years. Costs are well below those of artificial regeneration.

While shelterwood accommodates the basic biological requirements of longleaf pine better than the other methods and also fits the needs of most landowners, it is not a panacea. Where heavy hardwood undergrowth cannot be controlled without excessive damage to the pine overstory, it is necessary to clearcut. If the clear-

Figure 8.—Left: *Area in 1954 after removal of longleaf pine stand to release seedlings established under a shelterwood overstory after the 1947 seed crop.* Right: *View from same camera station in 1961. See frontispiece for 1974 view in this stand.*

cutting is done in narrow strips, natural reproduction may be obtained. The alternative is to plant or direct-seed. In many unmanaged second-growth stands the pine overstory is inadequate; shelterwood regeneration requires a minimum of 20 square feet of basal area per acre in suitable seed trees—less than this risks inadequate seeding. The method also requires close monitoring of seed crops, seedling establishment, and growth, so that cultural treatments can be properly timed.

USING A SHELTERWOOD SYSTEM

Management Before Regeneration

The shelterwood method works best if applied after steps have been taken to prepare for regeneration. Favorable understory conditions can be obtained most efficiently by frequent use of fire, especially toward the end of the rotation (fig. 9). In most well-stocked stands, periodic winter fires will kill back hardwood brush and keep it small. Exceptions are the more fertile sites and special

Figure 9.—*Well-managed longleaf. Frequent fire during the rotation has developed a clean understory, favorable to regeneration.*

areas such as palmetto understories in the Lower Coastal Plain, where summer fires or mechanical control may be needed. Where burning has controlled hardwoods and brush and has limited the accumulation of litter, there is little difficulty in providing adequate seedbeds. Cattle can also help condition the understory but must be excluded or carefully controlled after seeds germinate.

Cutting practices during intermediate management are important. Because longleaf pines prune themselves readily, most dominants and codominants contain wood of good quality. They can be favored by thinning from below. Such thinning develops the large crowns essential to abundant seed production. After stands reach seedbearing age, trees that produce abundant cones should be retained when feasible.

In all intermediate cuttings, care should be exercised to avoid creating openings that will invite hardwood encroachment. Even if they have been carefully managed, however, most stands that need regeneration today have some openings from lightning strikes, beetle kills, windfalls, or initial understocking. To rehabilitate such areas requires special mechanical, chemical, or fire treatments, or a combination of treatments.

Making the Preparatory and Seed Cuts

The shelterwood method is most efficient when cutting areas comprise complete burning blocks. Such blocks may vary from 25 to 100 acres, and should be bounded by natural or artificial breaks. Larger units increase the difficulty of fire control.

Where smaller shelterwood areas are desired, prescribed burning of individual cutting areas may not be feasible. In such irregular situations, stands of various shapes and ages may be included in one burning block. Burning must then be restricted to the dormant season, and the prescription be adjusted to best meet the needs of all the stands, with particular attention to those most vulnerable to fire. Mechanical seedbed preparation may be required when fire cannot be used.

The shelterwood method usually employs two or three cuts. In the three-cut method, a preparatory cut is made and then is followed in about 5 years by a seed cut that removes all trees not needed for seed production. The third cut removes the overstory after the seedling stand is well established. The two-cut method is similar except that the preparatory and seed cuts ar combined.

Objectives of the preparatory cut are to tak out trees that are not suitable as a seed source and to develop large crowns on the trees left Optimum residual density ranges from 60 squar feet of basal area per acre on the poorer sites t 70 square feet on the better (fig. 10). The pre paratory cut is essentially a thinning, mostly from below, leaving the largest trees of good quality. Where the stand has been under man agement through the entire rotation, the last thinning before the regeneration period may constitute the preparatory cut. Some advance reproduction occasionally develops after the preparatory cut, but adequate amounts are not expected until after the seed cut.

The seed cut is designed to maximize seed production and develop a well-stocked stand of reproduction. By reducing the density of the overstory, the cut minimizes logging damage to seedlings during the removal cut. It is highly important that the trees to be left are carefully selected. They should be more than 30 years old, 10 inches or more in d.b.h., and preferably above average in height, form class, and volume. In addition, they should be above average in fruitfulness as evidenced by abundance of open cones under them. Ideally, they should also have branches of small diameter and flat branch angles, and should be free of crook, spiral, excessive knot stubs, or forks.

Hardwood control, if needed, should be completed before the seed cut or promptly after. Where labor is available, hardwoods can be deadened by injection of concentrated 2,4-D. Moyer (1967) used 1-milliliter injections at 3-inch spacings to control hickory and dogwood in summer, and at 5-inch spacings to control oaks in all seasons. Other chemical applications may also be effective. The treatments may need to be followed by burns to control resprouting. Full-tree chipping, where feasible, provides an excellent means of removing unwanted hardwoods and pines from a shelterwood understory. Heavy brush cutters may also be used if damage to overstory trees and their roots can be avoided. Chipping and brush cutting usually can be most easily accomplished in conjunction with the seed cut.

Several years may elapse between the seed cut and establishment of adequate regeneration. Reduced stand density permits vigorous growth of

Figure 10.—*Cooperative shelterwood experimental area, after preparatory cut reduced the basal area to 70 square feet per acre. Seed cut will be delayed 5 years to allow crowns to enlarge prior to reduction of the stand to 30 square feet per acre of seed bearers.* (Photo by Eglin Air Force Base.)

ardwoods, which must be kept under control by imely burning. On some sites, especially the bet- er ones, burns may have to be made during the rowing season. Brush control is needed espe- ially when restocking is delayed 5 years or nore.

Seed production is maximized at a density of about 30 square feet of basal area per acre. This amount of overstory holds brush in partial check. Where available, trees totaling this density should be left in the seed cut (fig. 11). They should be spaced out individually and not left in

Figure 11.—*Two-cut shelterwood test area, Bladen Lakes State Forest. The seed cut, bringing the stand to 30 square feet of basal area per acre, has just been completed. Decay of logging debris will greatly reduce surface fuel before burns are made to control brush or prepare a seedbed.* (Photo by North Carolina Forest Service.)

groups. In many stands seed bearers are scarce; then no preparatory cut is made, but the best available trees, up to 30 square feet per acre, are left.

Loggers must avoid skinning trees at the base, since such damage invites black turpentine beetles (*Dendroctonus terebrans* [Oliv.]). Barring a hurricane or similar disaster, mortality of unscarred seed bearers should be nominal. Over a 15-year period, losses on the Escambia Experimental Forest averaged less than one tree per 5 acres per year. Most losses were from lightning.

Monitoring the Seed Crop

After the seed cut, annual forecasts of seed crops should be made for the purpose of timing seedbed preparation. No completely satisfactory appraisal method has been devised, but counting conelets in the spring with binoculars will give good estimates for the current year's crop. Estimates based on flower counts may vary considerably from actual production, because losses of flowers are variable and sometimes heavy.

Binocular counts must be made in the spring "naked season" (Croker 1971b). At this time the flowers for the seed crop 18 months hence are visible at the end of the new shoots, which have not yet developed needles; the conelets of the current year's crop are easily seen among the foliage of the previous year's growth. The "naked period" usually occurs in April but sometimes is delayed until May.

For each regeneration area where a prediction is needed, 50 or more sample trees should be selected in an unbiased manner. To make the counts the observer should stand at a distance of about one tree height from the sample tree, and with the sun at his back. With 7-power binocu-

ars he should then count all flowers he can observe without moving. Counts should proceed ystematically throughout the crown. After lowers have been counted, conelets should be allied by the same procedure.

To estimate seed production per acre, separate mputations are needed for conelet and flower unts:

To compute seed per acre in the current year, double the average number of conelets per tree, then multiply by trees per acre, and multiply the result by estimated number of seeds per cone.

To estimate seeds per acre in the following year, multiply the average flower count per tree by number of trees per acre and multiply the result by expected seeds per cone.

stimates based on conelet counts should be easonably accurate about 90 percent of the time lower counts are not nearly so reliable, but evertheless are still useful. At minimum, they dicate when a crop failure may be expected, nd thereby enable the forester to avoid untimely eedbed preparation.

The amount of seed necessary to insure a new and depends on the condition of the seedbed, redator pressure, the soil, understory conditons, and existing seedling stocking. Table 2, hich summarizes data from a 5-year study in labama, indicates numbers of seeds and newly tablished seedlings that provided 500 fast-owing, brown-spot resistant trees per acre at e 6 years. Survivors at this age totaled many ore than 500 per acre, but only about 20 percent ere thrifty and in height growth. Table 2 should t be regarded as a prescription, for conditions ry widely from one locality to another. Land nagers should determine requirements from eir own experience.

Fortunately, shelterwood regeneration has a mber of safety factors. Ability to predict each ed crop at two times, one a year before the oth- affords opportunity to adjust for early misculations. Mechanical scarifying, supplemental seeding, or both, can boost a marginal crop to afe level. If a seed crop is inadequate, the land mains in a reasonably productive condition ile awaiting fill-in reproduction.

Preparing the Seedbed

Seedbed preparation must be carefully timed. It is usually ineffective if done more than 1 year in advance, because litter or grass will accumulate and reduce germination. If hardwood control has been adequate, the ground cover before preparation should consist largely of grasses, forbs, and brush under 4½ feet high. Any areas of palmetto or larger hardwoods should be treated as previously described.

Table 2.—*Amount of seed and number of established seedlings per acre in spring after seedfall, to provide 500 thrifty, well-distributed seedlings in height growth at age 6 years*

Seedbed treatment	Brushy site, good soil		Grassy site, poor soil	
	M seeds	*Seedlings*	*M seeds*	*Seedlings*
Fall burn[2], mechanical	30	6,500	56	10,000
Fall burn	51	10,500	71	12,000
Winter burn[3], mechanical	38	8,000	43	8,200
Winter burn	63	13,200	92	16,800
No burn, mechanical	64	12,000	233	35,800
No burn, no other	..... Impractical ...		....	

[1] After Croker, 1975 (in press).
[2] One to three months prior to seedfall.
[3] Six to ten months prior to seedfall.

The forester has two options for seedbed preparation—the winter before seedfall or the following autumn just before the cones open. A fall burn may provide a bed for two seed crops—the current year's and the next. The relative efficiency of the two seasons is indicated in table 2. Survival is better on fall burns. Growth is also improved over that on a winter burn made 9 or 10 months before seedfall. But a winter fire will do less damage to advance reproduction, and when predators are numerous there may be fewer seed losses in a 1-year rough than on a fresh burn. If many tracts are ready for seedbed preparation, dividing the total job between two seasons allows efficient use of men and equipment.

It is the experience of many people, including ourselves, that burning is essential if mechanical treatment is not done. Burning is an art acquired by experience. A keen knowledge of how fuels, weather, and topography affect the behavior and impact of fire is necessary. The aim is to get a clean burn without damaging the seed bearers. Where fuels are largely grasses and forbs, flank or head fires can be used when weather is suitable and where topography is level or moderately sloping (fig. 12). Normally, burning should be

Figure 12.—*Strip-firing a seedbed burn in a two-cut shelterwood test area, Escambia Experimental Forest. The seed cut has left selected trees with average basal area of 30 square feet per acre.*

done within 2 or 3 days after a soaking rain, at air temperatures of 80° F or less, and when relative humidity is above 40 percent. Winds should be a steady 5 to 8 miles per hour at ground level to dissipate the heat and prevent damage to the tree crowns. Special prescriptions are needed for steep terrain and heavy fuels.

Combining a low-cost mechanical treatment with burning should increase establishment, survival, and growth of seedlings, especially on good sites where brush and small hardwoods are common. Mechanical treatment is absolutely essential if burning is not done. The various implements include disks, choppers, and rototillers. A low-cost treatment that has proven very effective in local tests near Brewton, Alabama, is scaribedding, accomplished with an implement similar to the one in figure 13.

Protecting Reproduction

Once seedlings germinate under the shelterwood overstory, they need protection. Rabbits may be troublesome during the first winter. Un til the trees reach sapling size, hogs and shee must be completely excluded and cattle grazing if permitted at all, should be at low rates o stocking.

Fires should, if possible, be kept out until re production is released in the removal cut. Whe necessary to burn through partially stocke seedling stands for seedbed preparation or brus control, it is best to delay until logging slash ha rotted for 2 years and then to use only a coo winter fire.

Making the Removal Cuts

The removal cut is not made until establishe reproduction is adequate in amount and distri bution. Inventories should be taken annually and full allowances made for probable mortality

Stocking must be determined; it can be easil apparised with a mechanical sample of circula plots. Common plot sizes are ¼ milacre (radiu 1.86 feet) and 1 milacre (radius 3.72 feet). Num

Figure 13.—*This scaribedder, combining a chopper with a fire plow, stretches short seed crops by providing lanes of exposed mineral soil. The machine, on which bedding disks may be substituted, supplements prescribed fire.*

r of plots required varies in relation to stock-
g, as indicated in table 3; a preliminary esti-
ate of stocking is therefore necessary. The
mpling procedure is discussed by Freese (1962,
20 ff.). In winter, green seedlings contrast
ith dead grass and are easy to see, but costs can
reduced by combining the seedling count with
e strobilus counts in spring.

Table 3.—*Number of sample plots required to provide stocking estimates within indicated confidence limits at 95-percent probability level*[1]

rcent of quadrats stocked (or nonstocked)	Confidence interval (percent)		
	±4	±5	±6
50	625	400	278
60	600	385	267
70	525	336	233
80	400	256	178
90	225	144	100
95	119	76	53

[1] Derived from Freese's (1962) table 3.

A widely accepted criterion of success is at least 500 well-distributed crop seedlings per acre at heights (3 feet or more) that are relatively safe from fire. As was indicated in connection with table 2, this 500-tree objective requires many more seedlings at earlier stages of development. Table 4, which is based on table 2 and is thus subject to the same reservations as regards local conditions, provides estimates of safe stocking before the removal cut. It allows for average mortality from natural causes, necessary prescribed fires, and logging damage; there is also some provision for unforeseen mortality. It is assumed that the reproduction will be protected from wildfire, hogs, and other livestock. Heavy initial stocking has the advantage of attaining desired stocking from the 20 percent or so of seedlings with above-average vigor and brown-spot resistance.

Once regeneration is adequate, the overstory should be removed. Within limits, the removal cut can be timed to fit harvesting programs or other management considerations, but usually removal at seedling age 1 or 2 years is best. If fire is kept out the seedlings will survive for a long time under an overstory, but they will not grow well.

An overstory of 30 square feet of basal area per acre can be removed in one cut. Heavier overstories should be harvested in two stages to avoid excessive damage by smothering from logging slash. No other special precautions will be needed if skidding under extremely wet conditions is avoided and log landings are carefully located. Some losses to pales weevil may occur after logging but will usually be within the margin of safety provided in table 4.

Post-Harvest Treatments

Once the overstory has been removed, height growth is the major concern of the forester. By reference to table 5, the percentage of seedlings in active height growth can be estimated on the basis of age at release and time since release. Values in the table are, of course, broad averages and may be affected by site and other factors. Rootcollar diameter is a good indicator of the time height growth begins. Usually the starting point is 1 inch.

Brown spot may slow the initiation of height growth. The only practical control in natural stands is prescribed fire. If logging slash is abun-

Table 4.—*Safe stocking levels at the time of removal cut, in relation to site and seedbed treatment*[1]

Seedbed treatment	Brushy site—good soil			Grassy site—poor soil		
	¼-milacre stocking	Milacre stocking	Trees per acre	¼-milacre stocking	Milacre stocking	Trees per acre
	Percent		*No.*	*Percent*		*No.*
Fall burn, mechanical	45	90	4,200	60	97	6,100
Fall burn	65	98	6,900	65	98	6,700
Winter burn, mechanical	40	87	3,800	45	90	4,000
Winter burn	60	97	6,600	60	97	6,000
No burn, mechanical	60	97	6,000	90	100	15,000
No burn	...	...	...	...	...	...

[1] Based on 4-year survival after removal cut, as reported by Croker (1975, in press). Values for ¼-milacre and 1-milacre stocking are estimated from unpublished data deriving stocking percents from number of seedlings per acre.

Table 5.—*Percentage of longleaf pine seedlings in active height growth, by seedling age and time since overstory removal*[1]

Seedling age at release (years)	Years after release								
	0	1	2	3	4	5	6	7	8
0	0	0	0	0	2	7	16	28	41
1	0	0	0	1	4	10	21	34	48
2	0	0	0	2	6	15	28	41	54
3	0	0	1	4	10	21	34	47	60
4	0	0	2	6	15	27	41	54	65
5	0	1	4	10	21	34	47	59	70
6	0	2	6	15	27	40	53	65	74
7	1	3	10	20	33	47	59	69	78
8	2	6	15	27	40	53	64	74	81

[1] Data from Coastal Plain and Mountain provinces of Alabama (Boyer 1976). Stepped line denotes age beyond which 20 percent of seedlings are in active height growth.

dant, fires should be avoided during the first 2 years after the removal cut, but brown spot does not usually become severe during this period.

Prescribed burning should be done very carefully. The degree of infection and possible damage to the stand should be determined from a survey. About 100 milacres are required to make a diagnosis for a stand. Examinations should be confined to the best or crop seedlings on each milacre.

If crop seedlings have less than 20 percent infection, and especially if they are in a stage susceptible to damage, burning should be postponed. But if the average rate of infection on crop seedlings is over 20 percent and expected fire damage is light, a prescribed burn should be made in the dormant season. Headfires will do a good job in proper weather—temperature 70° F or less, relative humidity 40 percent or more, and a good steady wind of 5 to 10 miles per hour at seedling level.

After removal cuts, stands may need burni for control of brush; the fire may also succes fully thin overdense seedlings.

A final evaluation of regeneration succe should be made when the crop seedlings are height growth. The stocking goal is 500 well-d tributed crop seedlings per acre—the equivale of 100-percent stocking of 2-milacre plots (ra us 5.3 feet if the plots are circular).

For various reasons, small areas sometimes r main unstocked. Perhaps the best practice is plant them with nursery-grown seedlings aft the overstory has been removed.

After a well-stocked stand is established a released, precommercial thinning usually will unnecessary, since longleaf expresses dominan better than the other pines. If needed, it shou be completed before seedlings are 4½ feet hig

SOME TEST RESULTS

Large-scale pilot testing of the shelterwood approach has been in progress over the past 20 years. Some of the early stands have been carried through to pole size, and good seedling catches have also been obtained in the more recent trials. On the Escambia Experimental Forest a 55-acre compartment was reproduced from the 1955 seed crop by a two-cut method (fig. 14). On the Kisatchie forest, reproduction has been obtained in both strip and group shelterwood in 13 forty-acre compartments (fig. 15). Two areas in the Mountain and Piedmont provinces of Alabama were reproduced with two-cut shelterwoods from the 1951 seed crop.

Beginning in 1966 a regional test of two-cut and three-cut shelterwoods was installed over a 5-year period. Cooperators include three State forest services, four national forests, a pulp company, an investment owner, and a military base. Test areas have been established in seven States: Louisiana, Mississippi, Alabama, Florida, Georgia, North and South Carolina. Units range from 12 to 40 acres in area. Seed cuts have been completed on 13 tracts, including 10 two-cut shelterwoods and 3 three-cut shelterwoods (table 6). Adequate regeneration is established on all of the three-cut areas and on seven of the two-cut areas. Two of the three remaining two-cut areas are partially stocked and awaiting fill-in from an additional seed crop. The third is in a greatly overstocked stand in Okaloosa County, Florida, on a difficult flatwoods site heavily infested with palmetto. In addition, on five of the seven three-cut areas where the seed cut it pending, considerable advance reproduction has come in as a result of the preparatory cuts. One of the two with little regeneration is also in Okaloosa County.

Removal cuts are yet to be made in most of the satisfactorily regenerated areas, but their stocking is adequate to insure acceptable stands after logging. The 10 adequately regenerated

Figure 14.—*Longleaf sapling stand 6 years after removal cut. It is part of a 55-acre compartment regenerated by the two-cut shelterwood method from the good seed crop of 1955. Escambia Experimental Forest.*

Figure 15.—*Two successful shelterwood areas on the Escambia Experimental Forest. The saplings in the foreground are from the 1958 seed crop; the pole stand in the background is from the crop of 1947.*

Table 6.—*Progress in regional longleaf pine shelterwood tests*

Location by county and State	Method	Year of seed cut	1974 stocking		Status
			Milacre percent	Thousand trees per acre	
Perry, Alabama	Three-cut	1970	98	126	Ready for removal cut
	Two-cut	1967	99	101	Ready for removal cut
Coosa, Alabama	Three-cut	1969	100	52	Removal cut made
	Two-cut	1966	93	19	Removal cut made
Leon, Florida	Three-cut	Pending	99	21	Seed cut scheduled
	Two-cut	1967	100	21	Ready for removal cut
Santa Rosa, Florida	Three-cut	Pending	95	2	Seed cut scheduled
	Two-cut	1968	84	3	Needs fill-in reproduction
Perry, Mississippi	Three-cut	1971	100	24	Ready for removal cut
	Two-cut	1967	97	30	Removal cut made
Grant, Louisiana	Three-cut	Pending	92	24	Seed cut scheduled
	Two-cut	1968	97	91	Ready for removal cut
Decatur, Georgia	Three-cut	Pending	7	1	Seed cut scheduled
	Two-cut	1968	40	3	Needs fill-in reproduction
Okaloosa, Florida	Three-cut	Pending	1	0	Seed cut scheduled
	Two-cut	1969	0	0	Needs fill-in reproduction
Bladen, North Carolina	Three-cut	Pending	75	4	Seed cut scheduled
	Two-cut	1969	96	11	Ready for removal cut
Chesterfield, South Carolina	Three-cut	Pending	84	7	Seed cut scheduled
	Two-cut	1970	92	8	Ready for removal cut

areas required an average of 3.5 years to achieve a new stand, the range being from 1 to 6 years. Prospects are that all test areas except possibly those in Okaloosa County will regenerate with the next good seed crop.

Although the studies are not yet complete, these results are convincing evidence of the effectiveness of the shelterwood method for regenerating longleaf pine naturally.

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Research has developed guides for consistent natural regeneration of longleaf pine by a shelterwood system. Key measures include hardwood control by fire and other means, timely preparatory and seed cuts, seed crop monitoring, seedbed preparation, protection of established seedlings, prompt removal of parent trees when reproduction is adequate, and control of competition and brown-spot disease after the removal cut.

Additional keywords: *Pinus palustris*, shelterwood, prescribed burning, timber management systems.

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Ten-Year Results In a Cottonwood Plantation Spacing Study

R. M. Krinard and R. L. Johnson

Southern Forest Experiment Station
Forest Service
U.S. Department of Agriculture

1975

TEN-YEAR RESULTS IN A COTTONWOOD PLANTATION SPACING STUDY

R. M. Krinard and R. L. Johnson[1]

During the first 10 years, unthinned cottonwood planted at four spacings grew from 2.8 to 3.4 cords per acre per year in trees 5.0 inches in d.b.h. and larger. Two basal area controlled thinning treatments did not increase yields. Initial spacings were 4 by 9, 8 by 9, 12 by 12, and 16 by 18 feet on Commerce-Convent soils. Only trees at the widest spacing averaged an inch of diameter growth annually for the 10 years.

Additional keywords: *Populus deltoides*, thinning, growth and yield.

Cottonwood is the fastest growing tree in the South and a valuable veneer, lumber, and pulp species. An estimated 40,000 to 50,000 acres of eastern cottonwood (*Populus deltoides* Bartr.) have been planted in the lower Mississippi River valley. Initial tree spacings were generally 9 by 9 or 10 by 10 feet. At these spacings, the trees were expected to reach pulpwood size by the first thinning, to require no pruning, and to provide adequate stocking even if only two-thirds survived. Such spacings were the minimum in which traditional farm equipment could be used in first-year mechanical cultivation.

The effects of spacing and subsequent stand manipulation on cottonwood growth is not known. This paper covers the first 10 years of a study to determine the relationship of diameter and volume growth to initial spacing and basal area control of stocking in cottonwood plantations.

METHODS

Twenty-inch run-of-the-bar cuttings were planted in January 1963 at spacings of 4 by 9, 8 by 9, 12 by 12, and 16 by 18 feet. Each increase in spacing halved the number of trees per acre. To obtain as high survival as possible, two cuttings were planted 4 to 6 inches apart at each planting spot. Where both cuttings sprouted, one tree was cut after the first year.

Measurement plots were 144 feet square and were surrounded by 50-foot buffer or isolation areas. There were eight plots per spacing.

The soils are medium textured and predominately Commerce and Convent. Commerce is fine-silty with from 18 to 35 percent clay in the top 40 inches; Convent is coarse-silty with from 10 to 18 percent clay. Both soils are classed as somewhat poorly drained. For natural stands of cottonwood on these soils, Broadfoot (1960) estimates a site index of 118 to 122 feet at age 30.

The study area had been in pasture for a number of years and was pan plowed to a depth of 14 inches before planting. Cultural treatments consisted of disking and scratching during the first year to control Johnsongrass. Several hoeings were also done on the 4 by 9 spacings after cross-scratching was stopped because of the height of the cottonwood. From the second year on, plots were mowed in late summer to knock down the Johnsongrass, weeds, and invading trees—predominantly boxelder.

Within each spacing, four thinning treatments were randomly assigned to the four plots with the highest basal areas and to the four with the lowest basal areas after 4 years. The thinning treatments were to reduce basal area per acre to 40, 65, 90, or 115 square feet whenever these values were exceeded by 15 square feet or more. Through 10 years, none of the plots achieved a basal area of 130+ square feet; therefore, the two plots per spacing scheduled to be thinned when they reached this level were never cut, and they served as unthinned checks (figs. 1 and 2). Of the eight plots [illegible] they reached basal areas of 105 square feet.

[1] The authors are stationed at the Southern Hardwoods Laboratory, which is maintained at Stoneville, Mississippi, by the Southern Forest Experiment Station, Forest Service—USDA, in cooperation with the Mississippi Agricultural and Forestry Experiment Station and the Southern Hardwood Forest Research Group.

Figure 1.—*General view of check plots after 10 years: upper left—4 by 9 spacing, upper right—8 by 9, lower left—12 by 12, lower right—16 by 18.*

Figure 2.—***Crown development within the check plots after 10 years: upper left—4 by 9 spacing, upper right—8 by 9, lower left—12 by 12, lower right—16 by 18.***

four (those in the 12 by 12 and 16 by 18 spacings) never reached the 105+ level and served as additional checks; and four (those in the closer spacings) only reached the 105+ level after 9 years and are therefore not considered in this paper.

Thinning was done on a single tree selection basis. First the obviously weak, poorly formed trees were removed. Then spacing became a major consideration. In nearly all cases, plots were thinned after crown shapes had formed, but there was little chance of selecting for crown shape or size since most trees within a spacing treatment developed in a similar manner.

Plots were sampled for survival from age 1 through 3. From age 4 through 10, diameters of all trees taller than 4.5 feet were measured with calipers. Dominant tree heights were randomly sampled by measuring five trees per plot after the fourth and sixth years, and four trees per plot after the eighth year. Heights in the ninth and tenth years were obtained in conjunction with volume sampling.

A sample of cut tree volumes was taken after the sixth, seventh, and eighth years. After the ninth and tenth years, standing tree volumes were obtained by means of 3P sampling and a Barr and Stroud dendrometer. Ten to 15 trees were sampled in each plot. The tree volumes were used in constructing local volume tables with 1-inch d.b.h. classes for plot volume estimates. Merchantable cubic volume was figured for volume outside bark in trees $\geq$5.0 inches d.b.h. to a 4-inch top outside bark. Total volume was volume outside bark to a total height for trees $\geq$2.0 inches d.b.h.

Values presented in Results represent the average of two plots except that four plots each were used for the 12 by 12 and 16 by 18 checks. Results and discussions in this paper do not imply statistical inferences where values are presented as larger or smaller and more or less.

RESULTS

Growth Characteristics

Diameter growth of individual trees varied widely within plots. For example, on a 16 by 18 plot, where average diameter of all trees at age 10 was 10.9 inches, one tree was only 4.0 inches. Conversely, on an uncut 4 by 9 plot, where average diameter was only 5.5 inches, a dominant tree was 13.9 inches. As earlier studies have shown (Mohn and Randall 1971), it was evident by the fourth year whether a tree was going to grow rapidly.

Clusters of trees showed either above or below average diameter growth in portions of many plots. Growth differences among clusters could well reflect microsite differences.

The pattern of diameter growth was similar for the 10 largest trees per plot in all treatments and spacings. Diameter growth was most rapid during the first 4 years and gradually decreased during the last 6 years.

Height growth of dominants varied among plots but appeared unrelated to spacing or thinning treatment. After 10 years, the average height for dominant trees was 86 feet, but the range by plots was from 79 to 94 feet. Generally, plots lower in elevation and probably with better moisture relations gave the best growth rates.

Check Plots

On uncut plots, survival increased as spacing increased (fig. 3). Thus, tenth-year survival ranged from 52 percent with the closest spacing to 87 percent with the widest. In all spacings, crowding or competition took mainly the small trees. Among trees 5.0 inches in diameter and larger, nearly half of the losses were attributable to wind damage. Mortality among all tree sizes increased considerably in the ninth and tenth years for all spacings except the 16 by 18.

Average diameter also increased as spacing increased (fig. 4). After 10 years, average d.b.h. was 5.3, 7.0, 8.2, and 10.2 inches for the 4 by 9, 8 by 9, 12 by 12, and 16 by 18 spacings. Largest

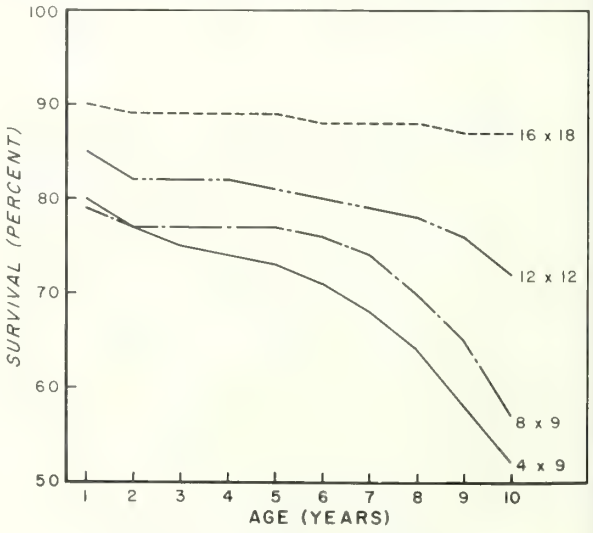

Figure 3.—*Survival of check plots.*

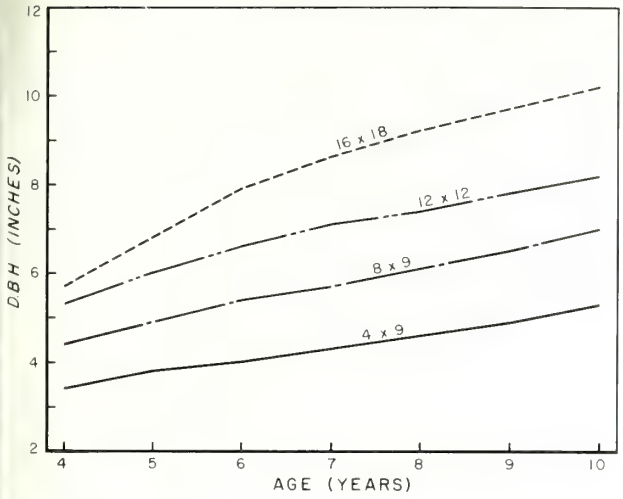

Figure 4.—*Average d.b.h. of check plots.*

diameters were in the 14-inch class (table 1). Maximum diameter growth occurred in the first 4 years for all spacings. Average annual diameter growth of all living trees apparently dropped to a minimum in the seventh year for the 4 by 9 stands and in the eighth year for the 8 by 9 and 12 by 12 stands, then increased slightly, mainly because of mortality among the smaller trees. In the 16 by 18 stands, average annual growth has decreased steadily since the fourth year.

The trend of decreasing diameter growth after the fourth year was also evident when only the 10 largest trees per plot were considered. For these trees, average annual diameter growth in the fifth through seventh year was only about one-half (12 by 12) to two-thirds (16 by 18) of their mean annual increment through age 4. During the eighth, ninth, and tenth years, their average diameter growth was only about one-third the mean annual increment through age 4.

Basal area growth was most rapid in the 4 by 9 spacing and slowest in the 16 by 18 spacing (fig. 5). Like diameter growth, annual basal area growth tended to reach a peak fairly early and then decrease. For the two closest spacings, annual basal area growth dropped during each of the last 6 years, indicating a peak before the fifth year. The 12 by 12 peaked in the fifth year; and the 16 by 18, in the seventh year.

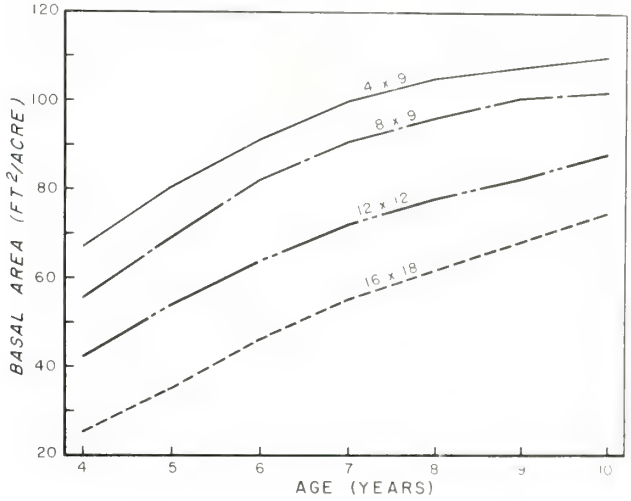

Figure 5.—*Basal area of check plots.*

Total volume at age 10 was inversely related to spacing (fig. 6). The 4 by 9 spacing with 611 trees per acre had the largest total volume, 3,544 cubic feet per acre. The 8 by 9 with half as many stems had only 100 cubic feet less volume than the 4 by 9. Total volume was lowest (2,700 cubic feet per acre) in the 16 by 18 spacing.

Maximum merchantable volume (3,033 cubic feet per acre) was achieved with the 8 by 9 spacing. There was slightly less merchantable volume in the 12 by 12, but it was concentrated on fewer, larger trees. The 4 by 9 had half again as many

Table 1.—*Diameter distribution of residual trees after 10 years by thinning treatments*

Diameter class (inches)	Check				55+/40 ft² per acre				80+/65 ft² per acre		
	4×9	8×9	12×12	16×18	4×9	8×9	12×12	16×18	4×9	8×9	12×12
	No. trees/acre										
<5.0	298	63	23	6	...	...	...	...	22	...	...
5.0–6.9	186	103	28	5	7	...	...	...	138	19	2
7.0–8.9	111	115	73	22	48	27	5	...	89	91	[illegible]
9.0–10.9	28	54	66	39	37	48	23	12	43	58	70
11.0–12.9	1	11	27	49	10	12	36	28	3	13	29
13.0–14.9	1	1	1	10	...	...	10	20			
15.0–16.9	...	...	...	...	...	...	1				
Total	625	347	218	131	102	87	75				102

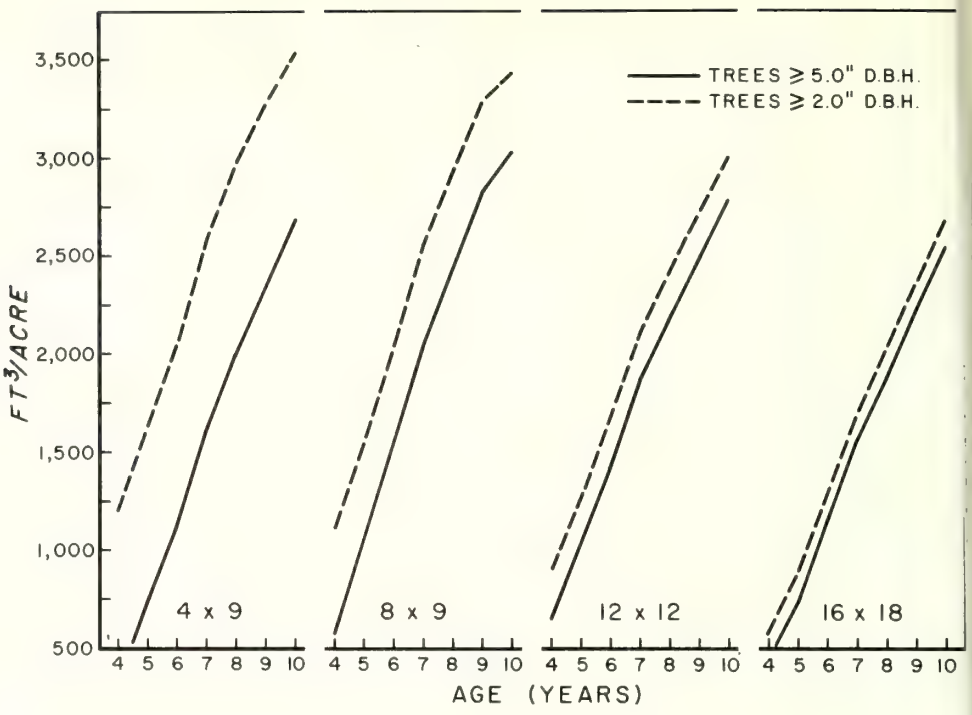

Figure 6.—*Merchantable and total cubic volume for check plots.*

merchantable trees as the 8 by 9, but average diameter was smaller, and as a result merchantable volume was about 20 percent less. The 16 by 18 plots had the lowest merchantable volume and from 70 to 200 fewer trees per acre than the other spacings. If larger threshold diameters are required for merchantability, then volumes and tree numbers are reduced (fig. 7).

Mean annual increment for total volume peaked at about 7 to 9 years for the three closest spacings; the 16 by 18 did not peak through 10 years (fig. 8). Mean annual increment for merchantable volume peaked in year 9 for the 8 by 9 spacing, but the other three spacings have not reached an obvious peak yet.

Thin 55 to 40

Thinning was done after 4, 6, and 9 years in the two closest spacings, after 6 and 8 years in the 12 by 12 spacing, and after 8 years in the 16 by 18 spacing. By age 10, spacing within all plots thinned back to 40 square feet exceeded the widest original spacing.

Just as in check plots, average diameter of 10-year residuals increased with increased spacing: 4 by 9 stands had the smallest average diameter (9.1 inches), and 16 by 18 stands had the largest (12.4 inches). Average diameters were 2 to 4 inches greater than those for trees in corresponding check plots (table 2). However, when only the 10 largest trees per plot are considered, the difference is much smaller. Only in the 12 by 12 spacing did the 10 largest trees in thinned plots achieve an average diameter of 1 inch more than that of the 10 largest trees in unthinned plots.

Merchantable volume (cut plus residual) was 52 to 552 cubic feet less in thinned plots than in corresponding check plots (table 2). Maximum production from thinned plots was 2,736 cubic feet in the 12 by 12 spacing; other spacings produced 83 to 91 percent as much. The thinned 4 by 9 plots produced the least volume of any spacing/treatment combination in the study (2,284 cubic feet).

In the first thinning, more than 90 percent of the trees cut from the two closer spacings and less than 20 percent of those cut from the two wider spacings were less than 5.0 inches in d.b.h. During the second cut, 77 percent of the trees removed from the 4 by 9 stands and 22 percent of those cut in the 8 by 9 were unmerchantable; all trees cut from the 12 by 12 were merchantable. The third cut was almost 100 percent merchantable in both 4 by 9 and 8 by 9 spacings (table 3).

Total volume (cut plus residual) in trees ≥2.0 inches in d.b.h. ranged from 2,514 cubic feet in the 16 by 18 spacing to 3,213 cubic feet in the 4 by 9 spacing. Yields were from 10 percent (two

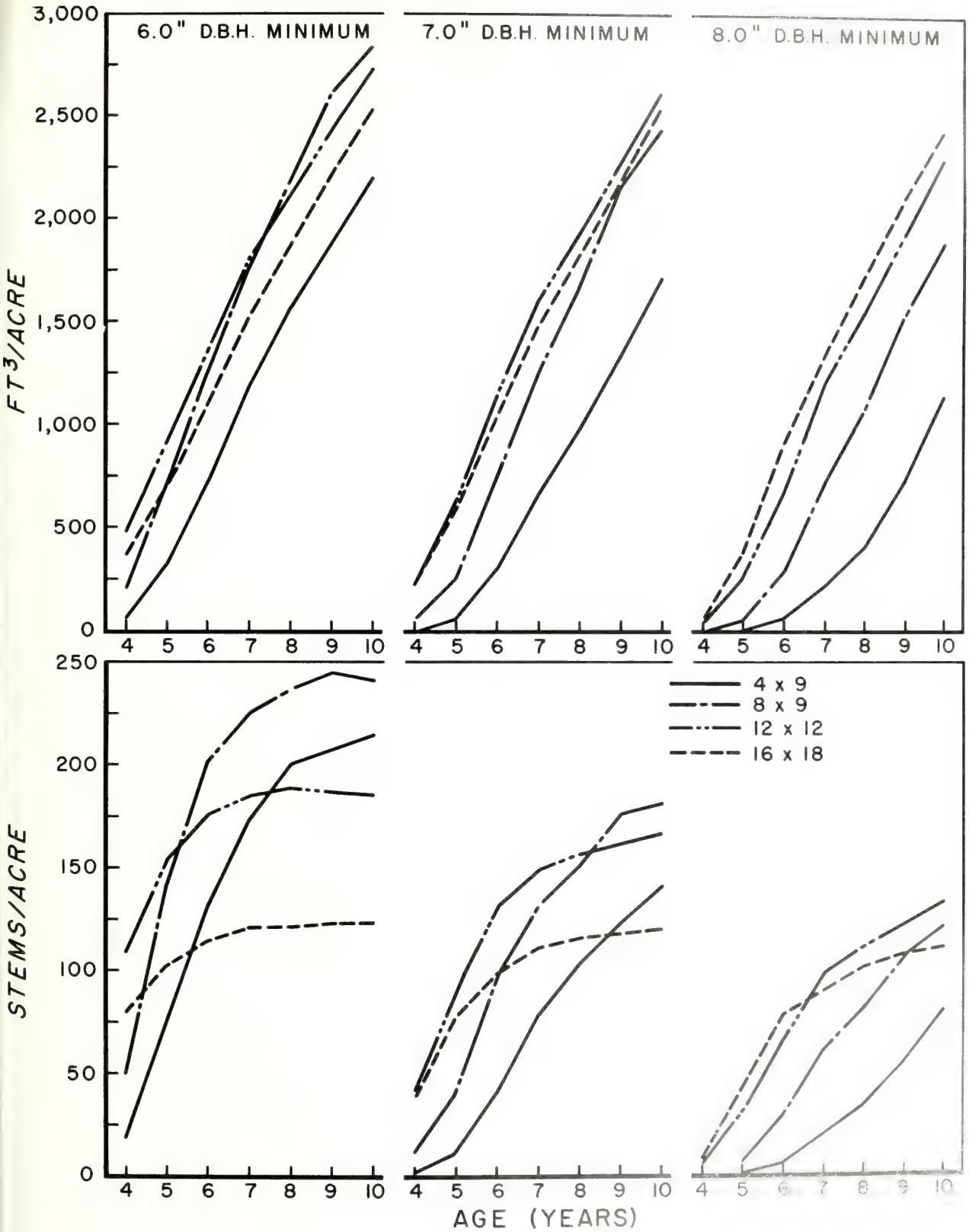

Figure 7.—*Cubic volume and density of check plots by spacing and threshold diameters (volume outside bark to 4-inch top outside bark).*

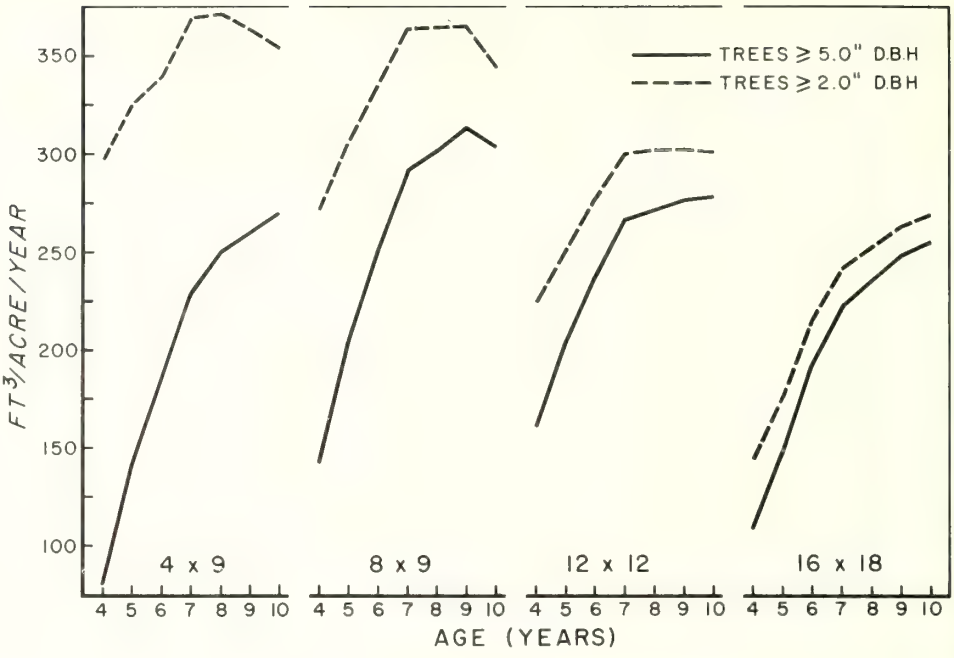

Figure 8.—*Mean annual increment of merchantable and total cubic volume for check plots.*

closest spacings) to 1 percent (12 by 12) less than yields from corresponding check plots.

Thin 80 to 65

The 4 by 9 plots were thinned after 5 and 7 years, the 8 by 9s after 6 and 8 years, and the 12 by 12s after 9 years. None of the 16 by 18 plots had exceeded 80 square feet of basal area through 9 years.

Again, diameter was directly related to initial spacing, and thinning did not increase diameter growth of uncut trees. Average diameter of 10-year residuals was smallest in the 4 by 9 plots (7.0 inches) and largest in the 12 by 12 (9.9 inches) (table 2). Although these diameters are somewhat larger than averages for trees on corresponding check plots, the mean diameters of the 10 largest trees per plot are quite similar for thinned plots and for checks (table 2).

Merchantable volume (cut plus residual) from thinned and unthinned plots differed little (table 2). The 4 by 9 was the least productive of the three spacings, and the 8 by 9 was the most productive. Both cuts in the 4 by 9 spacing and the

Table 2.—*Average diameter of all trees and of 10 largest trees per plot, and merchantable volume at age 10 by spacing/treatment combinations*

Spacing	Treatment	Plots	Average d.b.h.		Merchantable volume
			All trees	Ten largest trees	
		No.	*Inches*		*Ft³/acre*
4×9	55+/40	2	9.1	10.8	2,284
	80+/65	2	7.0	10.3	2,551
	Check	2	5.3	10.0	2,689
8×9	55+/40	2	9.7	11.1	2,481
	80+/65	2	8.7	11.4	3,058
	Check	2	7.0	11.2	3,033
12×12	55+/40	2	11.5	12.9	2,736
	80+/65	2	9.9	12.2	2,820
	Check	4	8.2	11.8	2,784
16×18	55+/40	2	12.4	13.9	2,397
	Check	4	10.2	13.1	2,549

Table 3.—*Merchantable volume and number of trees, cut and residual, in 10 years for two thinning treatments*

Spacing	First cut			Second cut			Third cut			10-yr. residual		
	<5.0 inches	≥5.0 inches	Vol.	<5.0 inches	≥5.0 inches	Vol.	<5.0 inches	≥5.0 inches	Vol.	<5.0 inches	≥5.0 inches	Vol.
	—No. trees—		Ft^3	—No. trees—		Ft^3	—No. trees—		Ft^3	—No. trees—		Ft^3
						55+/40ft²/acre						
4×9	685	3	8	123	37	262	1	71	540	...	102	1,474
8×9	245	23	64	28	99	355	1	58	604	...	87	1,458
12×12	23	98	514	...	37	452				...	75	1,770
16×18	6	47	615							...	63	1,782
						80+/65ft²/acre						
4×9	502	5	20	113	9	40				22	273	2,491
8×9	183	25	94	7	92	500				...	181	2,464
12×12	32	61	444							...	132	2,376

first cut in the 8 by 9 spacing were not commercial. Both cuts in the 12 by 12 were commercial, although 34 percent of the trees removed in the first cut were less than 5.0 inches d.b.h.

As with merchantable volume, total volume (cut plus residual) on thinned plots differed little from that on check plots. The 8 by 9 plots had the greatest yield, 3,588 cubic feet; and the 12 by 12 plots had the least, 3,070 cubic feet.

DISCUSSION

The present study on a good, but not excellent, cottonwood site indicates merchantable growth of up to 300 cubic feet, or 3.4 cords, per acre annually for the first 10 years might be anticipated. Total main-stem utilization would increase yields by 5 to 32 percent, with degree of increase in direct relation to number of trees harvested.

The forest manager should decide on the end product—pulpwood, sawtimber, or mixed products—before planting cottonwood. If pulpwood is his goal, he can choose between the 4 by 9, 8 by 9, and 12 by 12 spacings. Thinning is unnecessary and may lower production if done too early or excessively.

If all trees are to be harvested and pulped when mean annual increment peaks in the eighth or ninth year, then the 8 by 9 spacing appears best. This spacing produces about as much volume as the 4 by 9 but requires the planting and harvesting of only half as many trees. In addition, the smaller trees in the 4 by 9 stands mean a larger percentage of bark. The 12 by 12 spacing produces a total volume of 20 to 25 percent less than that of the other two spacings.

If only trees ≥5.0 inches d.b.h. are to be pulped, either the 8 by 9 or 12 by 12 spacing should be selected. In 10 years the 8 by 9 plots produced 9 percent more volume in 44 percent more trees than the 12 by 12 plots, but there were three times as many unmerchantable trees in the 8 by 9. Mean annual increment for the 12 by 12 spacing is likely to peak at about the 12th year but will probably not equal the rate of the 8 by 9. The 4 by 9 spacing is too close since at age 10 only half of the living trees may be merchantable size.

Some planters may be interested only in producing sawtimber (trees ≥13.0 inches d.b.h.). Of the spacings we tested, 16 by 18 appears best after 10 years because trees are from 2 to 5 inches larger in diameter than those at closer spacings, there are fewer trees to plant and care for, and there are fewer nonsawtimber trees to deal with. However, trees in this spacing will require artificial pruning because natural pruning will not occur soon enough to restrict limb knots to an 8-inch core.

Since diameter growth reflects crown diameter and length and since even in the widest spacing crowns were reduced to 30 to 40 percent of total height in 10 years, even the 16 by 18 spacing appears too close for maximum growth to sawtimber size. Conversely, spacings wider than 16 by 18, although maximizing diameter growth of individual trees to sawtimber size, would not allow full-site utilization for at least the first 10 years. Wider spacings would also result in poor bole quality unless an intensive program of artificial pruning were followed.

If mixed products (pulpwood plus sawtimber) are desired, timing of thinning becomes critical. To stimulate growth of residuals, thinning would likely have to occur within 3 years for the 4 by 9s, 4 years for the 8 by 9s, 6 years for the 12 by

12s, and 8 years for the 16 by 18s. Times will vary somewhat depending on tree growth, which is related to site quality and genetic make-up of planting stock. Once the critical period for thinning is passed, release seems to have little stimulus on crown enlargement and thus growth of residuals.

Thinning is further restricted by the tree size and the amount of volume that can be utilized. If only trees over 5 inches in d.b.h. will be used and if each thinning must produce a minimum of 2 cords per acre, we can draw tentative conclusions about the spacings tested. The 12 by 12 appears best because thinnings can be scheduled within a wide time range and still benefit residuals. The 4 by 9 shows little promise because a high proportion of trees never reach merchantable size and because competition restricts diameter growth of individual trees. More potential is visible in the 8 by 9s, but early thinning to favor dominants will result in lower merchantable yields than in the 12 by 12 and delaying thinnings would result in reduced growth of dominants. The 16 by 18 results in only partial site utilization and correspondingly low total yields during the first 10 years.

There is no apparent best spacing. Perhaps the best compromise of those tested is 12 by 12 feet, for it results in good pulpwood production with or without thinning, good average growth of dominants, and fair tree quality. This spacing provides enough stocking from planting one-half to one-fourth of the trees needed at closer spacings, provides flexibility for the forest manager to harvest after a pulpwood rotation with only slightly less production than the best pulpwood spacing (8 by 9), and provides for extending production into sawtimber with only a slightly longer rotation and somewhat better bole quality than the 16 by 18.

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Krinard, R. M., and R. L. Johnson

1975. Ten-year results in a cottonwood plantation spacing study. South. For. Exp. Stn., New Orleans, La. 10 p. (USDA For. Serv. Res. Pap. SO–106)

During the first 10 years, unthinned cottonwood planted at four spacings grew from 2.8 to 3.4 cords per acre per year in trees 5.0 inches in d.b.h. and larger. Two basal area controlled thinning treatments did not increase yields. Initial spacings were 4 by 9, 8 by 9, 12 by 12, and 16 by 18 feet on Commerce-Convent soils. Only trees at the widest spacing averaged an inch of diameter growth annually for the 10 years.

Additional keywords: *Populus deltoides*, thinning, growth and yield.

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Direct-Seeding Oaks on the Cumberland Plateau In Tennessee

Arnold L. Mignery

Southern Forest Experiment Station
Forest Service
U.S. Department of Agriculture

1975

DIRECT-SEEDING OAKS ON THE CUMBERLAND PLATEAU IN TENNESSEE

Arnold L. Mignery[1]

White, northern red, and black oaks can be established by direct seeding if acorns are protected and competing vegetation is controlled. Survival after 1 to 7 years averaged 12 percent in coves and 70 percent on upland plots. Height growth was slow.

Additional keywords: Cumberland Plateau, *Quercus alba*, *Q. rubra*, *Q. velutina*, stocking, survival, animal depredation.

Artificial regeneration with desirable oak species is one way to improve the culled, understocked hardwood stands of Tennessee's Cumberland Plateau. The forester has a choice between direct-seeding acorns or planting nursery stock. Both approaches encounter problems, but direct-seeding is potentially much cheaper.

By and large, seeding of oaks has been unsuccessful in the Eastern United States (Arend and Scholz 1969, Russell 1971), mainly because predators consume many of the acorns and competing vegetation suppresses the seedlings. Reports of successful seedling establishment rarely include information on subsequent performance (Johnson 1970, Sluder 1964, Sluder 1965, Sluder, Olson, and Jarrett 1961). Scholz (1964), however, observed good survival and growth up to 10 years for northern red oak in Wisconsin, and Mignery (1962) reported adequate second-year survival of white oak in Tennessee. This paper describes results of six studies conducted to augment data on germination, survival, and growth after direct-seeding.

METHODS

The six studies were installed from 1959 through 1963 on clearcut openings in partially stocked forests of the Cumberland Plateau, near Sewanee, Tennessee. Openings were rectangles ranging from 54 by 60 feet to 30 by 180 feet in size. To make the openings for studies 1 and 2, vegetation was cut but no silvicides were used. In the other four studies, silvicide was injected in large trees and sprayed on cut

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stumps of small stems. Brush and weeds were cut frequently during the first and second growing season of each study. There was little control of competition after the second year.

Table 1 synopsizes information on sites and variables of each study. Study 1 tested white oak (*Quercus alba* L.); study 2 tested northern red oak (*Q. rubra* L.). Studies 3 and 4 compared white and northern red oak; studies 5 and 6 tested these two plus black oak (*Q. velutina* Lam.).

Studies 1, 3, and 5 were on upland sites, previously occupied by low quality oak-hickory stands, on Hartsells soils. The other three studies were on north-facing cove sites, previously in mixed hardwoods, on stony Bouldin and Allen soils. Both sites have adequate rooting depth for oaks.

There were three to six replications of each tested variable, and variables were assigned randomly. Rows of 15 to 25 seedspots constituted plots. Stocking and survival data were computed as percentages and transformed to arcsin $\sqrt{\text{proportion}}$ for analysis of variance. All differences mentioned as significant were appraised at the 0.01 level.

All acorns were collected near Sewanee in the autumn before sowing. White oak for study 1 was planted 2 days after collection in late October 1959. Northern red oak acorns for study 2 were stored in an outdoor pit on the day collected and stratified until sown in late April 1960. Seed for all other studies was air-dried at room temperature for 2 or 3 days and then stored in plastic refrigerator bags at 40° F.

At each seedspot litter was scuffed aside and two acorns were inserted in holes made with a bar or dibble $\frac{3}{4}$-inch in diameter. Holes were closed by pressure, the acorn being covered with about 1 inch of topsoil. Where acorns had sprouted, care was taken to avoid damaging roots. At the end of the first growing season, the less vigorous seedling was removed from seedspots where two had survived.

In all six studies, half of the seedspots were screened to protect acorns from mammals and birds. For studies 1 and 2, cones of window screen about 5 inches in height and diameter were anchored with 12d nails (Wakeley 1954, p. 214). Later studies employed 12- by 4-inch cylinders of $\frac{1}{4}$-inch mesh hardware cloth, closed at the top with hog rings and anchored at first by wire pins or later with more effective 6-inch wire staples (Russell and Mignery 1966). When necessary to permit free height growth of seedlings, cones were removed or tops of cylinders opened.

Each study was maintained for several years. Inspections to determine survival were made after the first growing season and at termination. At the last inspections seedling heights were also measured. During the first growing seasons, study areas were observed for evidence of causes of mortality. In January and February 1962, traps baited with acorns were used in studies 3 and 4 to capture a sample of pilfering animals.

Table 1.—*Descriptions of sites and studies*

	Study 1	Study 2	Study 3	Study 4	Study 5	Study 6
Elevation, feet	1,860	1,280	1,850	1,500	1,850	1,500
Topographic position	Undulating flat	Cove	Broad ridge	Cove	Broad ridge	Cove
Slope, percent	0-2	5-10	5-10	5-15	5-10	5-15
Aspect	Variable	North	North	Northwest	North	Northwest
Soil series	Hartsells	Allen	Hartsells	Bouldin	Hartsells	Bouldin
Study installed	October 1959	April 1960	1961-1962	1961-1962	1963	1963
Study terminated	1965	1965	1965	1965	1969	1969
Species tested	White oak	Northern red oak	White oak, northern red oak	White oak, northern red oak	White oak, northern red oak, black oak	White oak, northern red oak, black oak
Variables compared						
Screens	x	x	x	x	x	x
Disking	x					
Hoeing	x	x				
March or May sowing					x	x
Winter or spring sowing			x	x		

RESULTS AND DISCUSSION

Field Germination

Seedlings bearing fully extended normal leaves were considered to have completed field germination. In studies 3 through 6, more than three-fourths of the field germination of white and northern red oak took place from May 1 to mid-July, but some continued until mid-August. Black oak germination began in mid-April and was completed by mid-July. In studies 1 and 2 all acorns were sprouting when sown. Seedlings began to appear in late April. Northern red oak field germination was about complete by late May, and white oak by mid-June.

There was virtually no second-year germination of any species.

First-Season Stocking

At the end of the first season, an average of 10 percent of seedspots were stocked on upland sites and 29 percent on cove sites, but stocking ranged from 2 to 91 percent for various species, site, and protection combinations (table 2). Protection by screens tripled stocking on upland sites and nearly quadrupled it in coves, though the average for protected plots was 60 percent on uplands as compared to 16 percent in coves. Within each study except the first, stocking was significantly greater on screened than on unscreened plots.

Table 2.—*Proportion of seedspots stocked with direct-seeded white, northern red, and black oaks in six studies*

Topographic position, study number, and oak species	First year		Close of study	
	Screen	No screen	Screen	No screen
	Percent			
Upland sites				
1. White	76	71	69	64
3. White	16	7	9	6
Northern red	50	8	37	5
5. White	60	9	42	11
Northern red	67	7	46	4
Black	91	17	68	14
Means	60	20	45	17
Cove sites				
2. Northern red	21	5	20	5
4. White	6	2	3	0
Northern red	16	2	9	1
6. White	68	22	0	1
Northern red	82	12	39	4
Black	85	28	12	5
Means	46	12	14	3

Variations in predation were evident (table 2). In study 1, where an abundant mast crop coincided with a low squirrel population, stocking on unscreened plots was only slightly less than under screens. Whether the higher unscreened stocking in studies 5 and 6 than in 3 and 4 reflects more mast or fewer predators in 1963 than in 1962 is unknown. Observation on unscreened cove plots of study 6 suggested, however, that predation was much lighter there in 1963 than in previous years.

Stocking at the end of the first growing season did not vary significantly between species except in upland studies 3 and 5. In study 3, white oak stocking was significantly lower than red oak; in study 5 black oak stocking significantly exceeded that of white and northern red oak. Observations do not, however, support a conclusion that white oak acorns are preferred by predators.

Neither disking in study 1, nor hoeing in studies 1 and 2, increased stocking at the end of the first growing season. Since competition had no measurable effect on germination or early survival, loss of acorns to predators probably accounts for most stocking differences.

Spring sowing produced significantly higher stocking (31 percent) than did winter sowing (9 percent) on the upland site of study 3, but on the cove site of study 4 the difference was not significant. In studies 5 and 6, stocking averaged 42 percent on upland and 49 percent on cove sites, but did not differ significantly between March and May sowings on either site.

Depredations to Seed and Seedlings

Disturbance of seedspots by animals was recorded during the first growing season of each study, but the data are of limited value because losses could not be confirmed without digging up the acorns. Despite this limitation, it seemed clear that effectiveness of screens varied considerably between studies. The low cones used in studies 1 and 2 permitted little pilferage, but lack of space for seedling development necessitated their early removal. In study 2, 74 percent of protected northern red oak seedspots were stocked in May when cones were removed, but stocking dropped to 28 percent 10 days later and to 21 percent by the end of the growing season. Acorns were robbed from many seedspots in studies 3 and 4 because the screen cylinders were not well anchored. In studies 5 and 6, high first-year stocking rates under screens reflect use of better fasteners, although higher stocking on unscreened seedspots suggests that predator pressure was also lower.

Trapping in studies 3 and 4 during January and February 1962 collected chipmunks (*Tamias striatus*) and white-footed mice (*Peromyscus leucopus*) on uplands, and one flying squirrel (*Glaucomys volans*) on a cove site. Although no gray squirrels (*Sciurus carolinensis*) were

captured, other evidence indicates that they were the chief predators. They were fairly abundant on all sites except in study 1.

Seedlings suffered limited damage from unidentified causes after the first growing season. In the second season root damage by small burrowing animals killed some white oaks in study 1. In the same study, 16 percent of the seedlings were clipped by cottontail rabbits (*Sylvilagus floridanus*) during the winter of 1960-1961, but all survived. In 1963 goats browsed many white oak and northern red oak seedlings; all recovered with little apparent loss of growth.

No severe insect or disease attacks were noted.

Survival

With frequent release during the first and second growing seasons, but little thereafter, 70 percent of seedlings established on uplands survived through the observation period (table 3). Survival on cove sites averaged 12 percent, probably because competition was more vigorous there. On uplands, survival on unscreened seedspots was higher than on screened plots, while the reverse was true on cove sites. This difference probably resulted from the low number of established seedlings on unscreened spots on cove sites, especially in study 4.

There was no evidence from studies 1 and 2 that survival at age 6 was influenced either by disking prior to planting or hoeing during the first growing season.

Height Growth

None of the study variables were designed to affect seedling height growth, and no evidence of such effects is apparent in the data (table 3). Surviving white oaks averaged 1.3 feet and northern red oaks 2.8 feet at ages 4 to 7; black oaks averaged 2.1 feet at age 7. Average annual growth was 0.25 foot for white oak, 0.30 for black oak, and 0.50 for northern red oak. Growth varied little between cove and upland sites.

Growth in these tests is comparable to that reported from other studies of the same species. Mixed oak seedlings averaged about 1 foot tall at age 6 (Sander and Clark 1971) and 2.5 feet at age 12 (Sander 1972) in southern Illinois. Paulsell (1965) reported a mean height of 1.29 feet for 200 seedling oaks in Missouri averaging 7½ years old.

CONCLUSIONS

Until effective repellents or other methods are developed to protect acorns from predators, well-anchored hardware cloth cylinders appear most effective for maximizing oak establishment by direct-seeding. Cost is likely to limit their use to research and perhaps to propagation of superior strains of highly desirable species.

Table 3.—*Survival and height growth of direct-seeded white oak, northern red oak and black oak seedlings in six Cumberland Plateau studies*

Topographic position, study number, and oak species	Age of seedlings at close of study	Proportion of seedlings surviving			Mean ht. at close of study	Mean annual height growth
		Screened seedspots	Unscreened seedspots	Combined screened & unscreened		
	Years	*Percent*			*Feet*	
Upland sites						
1. White	6	90	91	90	1.4	0.24
3. White	4	56	79	63	1.2	.30
Northern red	4	75	60	73	1.9	.47
5. White	7	71	100	77	1.5	.21
Northern red	7	69	54	67	3.4	.49
Black	7	47	79	52	2.3	.33
Mean survival, all upland sites		68	77	70		
Cove sites						
2. Northern red	6	95	100	96	3.7	.62
4. White	4	50	0	38	1.1	.27
Northern red	4	63	25	57	2.0	.50
6. White	7	0	5	1	1.4	.20
Northern red	7	48	29	45	3.1	.44
Black	7	14	16	15	1.8	.26
Mean survival, all cove sites		45	29	42		

On upland sites, survival averaging 70 percent is probably acceptable for stand rehabilitation, provided that the seedlings are not overwhelmed by competing vegetation. Low survival for white and black oak on cove sites indicates need for cultural measures. The somewhat higher survival of northern red oak on cove sites is encouraging, but still too low.

Slow rates of early height growth handicap all three species. Though comparable to rates reported by others, they leave seedlings vulnerable to overtopping for as long as a decade (figs. 1 and 2). Poor survival on cove sites is believed to result primarily from such competition. Economical ways of controlling competition are essential to rehabilitation of Cumberland Plateau forests, especially the more productive cove sites.

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Figure 1.—*Direct-seeded white oak on an undulating flat of the Cumberland Plateau (study 1).* Above: *After three growing seasons, the mean height of all seedlings was 0.68 foot.* Below: *After 14 growing seasons, the tallest 10 percent of the trees ranged from 6 to 14 feet.*

Figure 2.—*Direct-seeded oaks in their 11th growing season on a broad ridge of the Cumberland Plateau (study 5).* Above: *Northern red oaks.* Below: *Black oaks.*

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1975. Direct-seeding oaks on the Cumberland Plateau in Tennessee. South. For. Exp. Stn., New Orleans, La. 11 p. (USDA For. Serv. Res. Pap. SO–107)

White, northern red, and black oaks can be established by direct seeding if acorns are protected and competing vegetation is controlled. Survival after 4 to 7 years averaged 42 percent in coves and 70 percent on upland plots. Height growth was slow.

Additional keywords: Cumberland Plateau, *Quercus alba, Q. rubra, Q. velutina,* stocking, survival, animal depredation.

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Brown-Spot Infection on Released and Unreleased Longleaf Pine Seedlings

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Southern Forest Experiment Station
Forest Service
U. S. Department of Agriculture
1975

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BROWN-SPOT INFECTION ON RELEASED AND UNRELEASED LONGLEAF PINE SEEDLINGS

William D. Boyer[1]

In south and central Alabama, brown-spot needle blight was found to be much less severe under a longleaf pine overstory than in the open. Light pine overstories had less effect than heavier ones, and hardwood canopies had no effect. Except under pine overstories, severity of infection declined with increases in amount of ground cover, but this relationship weakened after seedlings were 3 years old. Through age 3, the disease was worse on poor than on average sites, since ground cover increased with site quality. When reproducing longleaf pine by the shelterwood method, the forester can delay release for several years without danger of severe infection on seedlings too small to withstand a prescribed burn.

Additional keywords: *Pinus palustris, Scirrhia acicola,* prescribed burning, overstory density, site, ground cover.

The worst affliction of longleaf pine (*Pinus palustris* Mill.) seedlings is the brown-spot needle blight, caused by the fungus *Scirrhia acicola* (Dearn.) Siggers. This disease retards growth and may eventually kill the seedlings; it is frequently responsible for delay in initiation of height growth. Infection is usually worse on poor than on good sites.

Fungicide applications are effective in nurseries but impractical in the forest. Instead, winter fires are normally prescribed (Siggers 1932,1934). They defoliate seedlings and thus retard growth, but if properly executed will result in a net benefit (Bruce 1954, Wakeley and Muntz 1947).

The most promising approach to natural regeneration of longleaf pine is a shelterwood system in which seedlings are established as advance reproduction under overstories of medium density (Boyer 1964, Croker 1969, Croker and Boyer 1975). For various reasons, the forest manager often finds it desirable to postpone harvest of the overstory after the reproduction becomes established. Should such delays occur, the seedlings will survive but grow so slowly that they remain vulnerable to fire for several years (Boyer 1974). There is

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evidence, however, that a pine canopy may slow development of brown sp and thus make early sanitation burns unnecessary (Boyer 1963; E. W. Ge mer, unpublished report, Southern Forest Experiment Station, 1932). Th paper reports four studies on relation of infection to overstory density of pin and hardwoods, and to seedling age at time of release.

Procedures

Study 1 (pine overstory density).—Pine overstories of 9, 27, and 45 squa feet of basal area per acre were created on square 2.5-acre plots in 40- to 6 year-old stands averaging 65 square feet of basal area per acre. The plots we on the Escambia Experimental Forest in southern Alabama, and were esta lished in the spring of 1957. Ten 4-milacre subplots were systematically esta lished within each plot.

Additional densities of 30, 60, and 90 square feet per acre were studied i uncut stands; each density was sampled by ten 4-milacre plots scattere throughout a 600-acre area of the experimental forest.

Finally, ten 4-milacre plots sampled a zero overstory. They were on a area that had been clearcut in January 1957; basal area before clearcuttin averaged 35 square feet per acre.

Within each 4-milacre subplot or plot, 12 seedlings from the 1955 see crop were marked and examined annually through the winter of 1963-196 Information recorded in this study, as well as in the other three, included: (1 root collar diameter of seedlings, (2) height to base of bud, and (3) brow spot infection in terms of current year's foliage destroyed, estimated to th nearest 10 percent.

The clearcut area was burned in January 1960. No other burns wer made. On 1 milacre in each 4-milacre plot, five classes of ground cover (woody grasses, other herbaceous plants, litter or rough, and bare ground) were esti mated to the nearest 5 percent. Estimates were made each autumn from 195 through 1963, excepting 1961.

Study 2 (seedling release from pine overstory).—Strips 2.5 or 3.3 chain wide and 20 chains long were clearcut along the east sides of three Escambi Experimental Forest compartments in January 1960, and along the north side of two more in February 1961. These cuts released seedlings, most of whic had become established from the 1957 and 1958 seed crops. Before logging the stands consisted of 50- to 60-year-old longleaf pines with densities ranging from 23 to 44 square feet of basal area per acre.

Five transects were randomly established at right angles to the long axi of each strip and paired with a similar transect in the adjacent forest. Tran sects were 132 feet long and 3.3 feet wide, thus comprising 40 quarter-milacre quadrats. On all stocked quadrats, the seedling nearest the center was marked for study. Annual winter examinations continued through December 1965. Prescribed burns were made in January of 1962 and 1964; three compartments were burned in the first fire, one in the second, and one in both.

Study 3 (timing of release).—This study was in the Mountain Province in Coosa County, Alabama, under longleaf stands averaging more than 100 years of age. Three blocks were laid out early in 1962; each consisted of six square 1.6-acre plots. Nine square 4-milacre subplots were systematically located in each plot. Within each subplot, 12 seedlings from the 1961 seed crop (three per milacre) were marked for study. Treatments consisted of complete overstory removal at 0 (April following seedfall), 1, 2, 3, and 5 years after seedling establishment. There was also an unreleased check. Overstory pine ranged from 17 to 43 square feet of basal area per acre, averaging 29; hardwoods ranged from 2 to 13 square feet, averaging 6. Seedlings were examined through age six. No plots were burned.

Study 4 (release from hardwood overstory).—Six blocks, each with six 0.1-acre plots, were established early in 1949. Two were on poor sites and two on average sites of the Escambia Experimental Forest, and two were on average sites of the Conecuh National Forest in south Alabama. Soils of the poor sites were mostly Alaga loamy sands, while average sites had sandy and fine sandy loams of Ruston, Benndale, Tifton, and Dothan series. Hardwood overstories ranged from 267 to 593 stems and 27 to 42 square feet of basal area per acre. Density on individual plots varied from 6 to 62 square feet. All pines had been removed before the study began.

Treatments consisted of complete overstory removal when seedlings from the 1947 crop were 1, 2, 3, 4, and 8 years old, plus an unreleased check. Later, five supplemental plots were added to each of the four Escambia blocks; treatments here included overstory removal 1 year ahead of seedfall (1951 seed crop), just after seedfall, at seedling age 1, and at age 2. There was also an unreleased check.

Examinations of the 1947 seedlings began with plot establishment and were repeated each winter through January 1952 and at 2-year intervals through December 1957. The 1951 seedlings were examined annually through February 1954, then biennially through December 1957. One hundred quarter-milacre quadrats were laid out contiguously in the center of each plot. The proportion of each quadrat covered by herbaceous vegetation was estimated at the nearest 10 percent at each examination through January 1952 for the 1947 plot series, and in 1953 and 1954 for the 1951 plot series.

Seedlings were thinned at age 3 years to a maximum of three per quadrat, at a minimum spacing of 1 foot. All main plots were prescribe-burned in winter when seedlings were 2, 5, and 7 years old. Supplemental plots were burned when seedlings were 3 years old.

Effects of Overstory

The development of brown spot from age 2 through 8 years differed with pine overstory density in study 1 (fig. 1). Infection at age 2 was low everywhere, but was highest in uncut stands of 30 square feet and next highest in

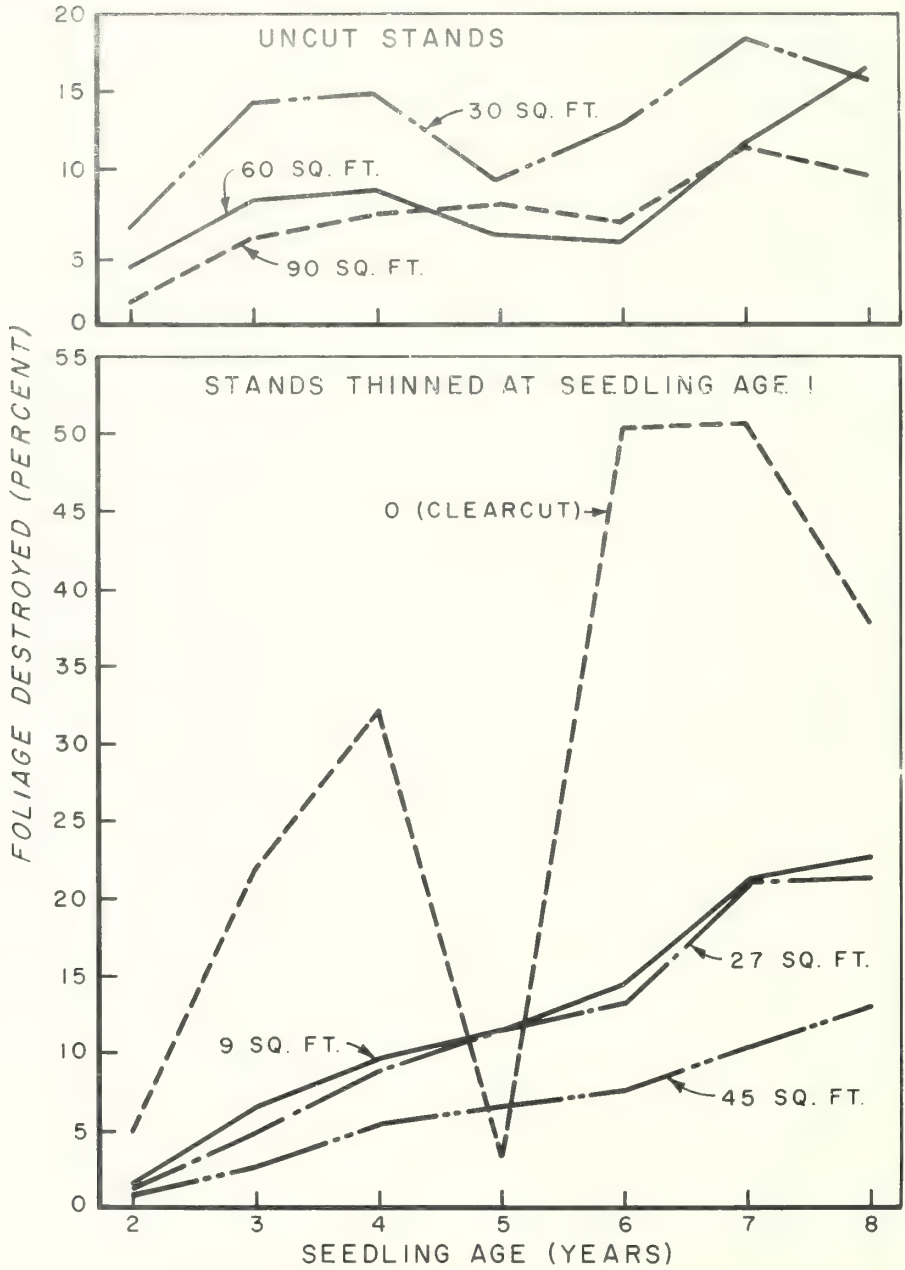

Figure 1.—*Development of brown spot in relation to overstory density (Study 1). The clearcut plots were prescribe-burned at seedling age 4 years, with resulting decrease in infection.*

clearcut stands. Infection at this stage apparently reflected differences in stand density before cutting.

After seedling age 2, brown spot increased rapidly on the clearcut area. A prescribed fire at age 4 lowered infection levels for 1 year, but after that the disease rose to a peak at age 6. Infection in the thinned stands increased slowly throughout the period of observation but never reached serious proportions. In the uncut stands, the disease also remained at low levels, reaching an equilibrium at age 3 and thereafter fluctuating only slightly.

Infection was lowest under overstories of 45, 60, and 90 square feet, and disease levels in these three density classes never differed significantly (0.05 probability level). Likewise, infection did not vary under stands of 9, 27, and 30 square feet, though it was significantly heavier under these light overstories, as a group, than under the heavier overstories.

On average, seedlings in the clearcut area were larger than those under overstories. Among seedlings with the same root collar diameter, infection in the clearing was double that under pine stands.

Development of infection on clearcut strips and in the adjacent forest was observed in study 2 for several combinations of release and prescribed burning (fig. 2). By the second year after logging, infection on the strips was heavier than in the adjoining forest, and the differences tended to increase as time went on. Fires reduced infection temporarily, but most of their effects disappeared after 2 years in the forest and after 1 year in the open.

For all years following release, infection averaged 19 percent in the open and 9 percent in the forest; the difference was significant. The greatest divergence was reached in the final year of measurement—36 percent in clearings and 13 percent in the forest.

Seedlings in the open grew almost twice as fast as those in the forest, root collar diameters at final examination averaging 0.96 and 0.54 inch. Infection can be expected to increase as seedlings gain size, becoming most severe in early stages of height growth. When seedlings of equal height were compared, those in the open had more than double the infection of those beneath an overstory (table 1).

A different pattern of disease development was observed in the Mountain Province of study 3. Infection remained low through seedling age 3 and then intensified (fig. 3). Intensification (increase in amount of foliage destroyed) occurred only after most of the seedlings—whether released or not—had become infected. At age 1, 23 percent of the seedlings were infected. Incidence increased to 34 percent at age 2 and 74 percent at age 3. Thereafter 99 to 100 percent of the

Table 1.—*Severity of infection in relation to seedling heights in study 2, December 1965*

Seedling height (feet)	Clearing	Forest
	Percent	
0	27	11
0.1—0.5	34	13
0.6—1.0	40	16
1.1—2.0	36	2
2.1—3.0	10	10
3.1+	3	2

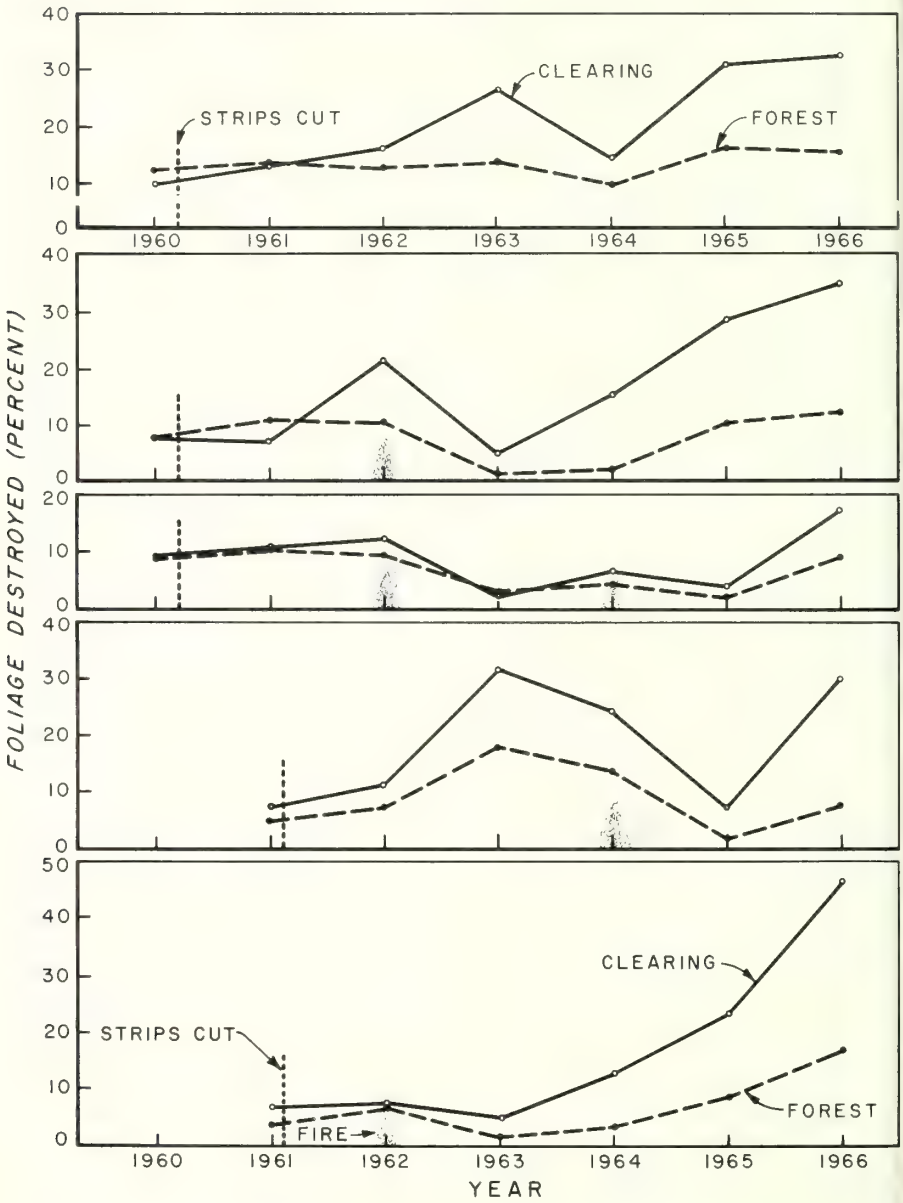

Figure 2.—*Annual changes in brown spot infection as influenced by overstory condition and fire schedules (Study 2).*

seedlings were diseased. Intensity under the pines, however, was not significantly less than in the clearcut openings, a result at variance with experience on the Coastal Plain.

In study 4, the disease was not significantly affected by presence of a hardwood overstory ranging from 6 to 62 square feet of basal area per acre. When

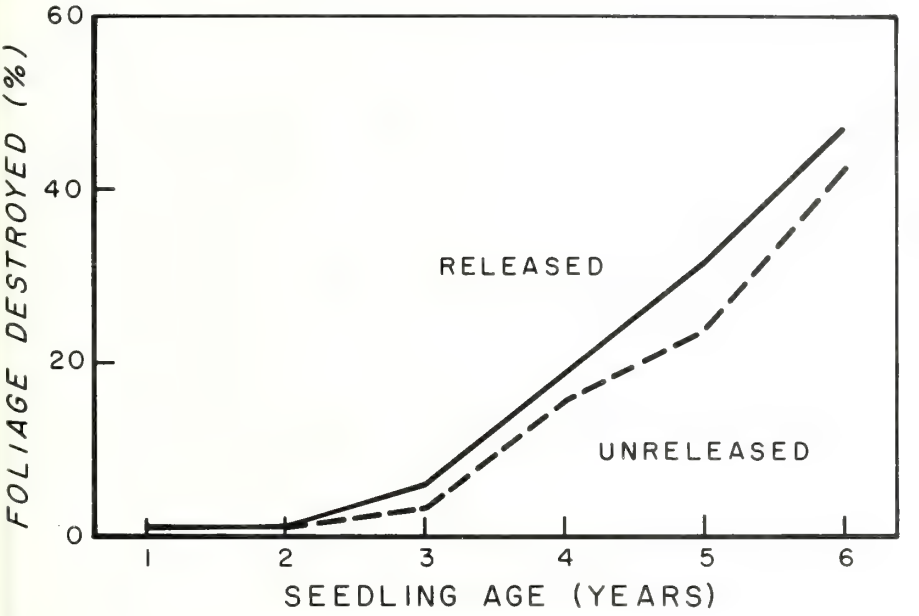

Figure 3.—*Infection on all seedlings from 1961 seed crop (Study 3).*

seedlings were 4 years old, infection averaged 41 percent under hardwoods and 44 percent in the open.

Severity on seedlings from the 1947 crop was uniformly low at age 1, but intensified rapidly (fig. 4). A fire at seedling age 2 failed to halt the disease, except briefly on the Conecuh. A peak was reached at age 4. After this, examinations were made every other year, so that annual fluctuations cannot be shown. Severity on poor sites significantly exceeded that on average sites, but the difference declined after seedling age 3.

The peak recorded for seedlings from the 1951 crop was at age 2, although infection at age 3 was not observed. Infection was worse on poor sites, with the difference declining after age 2.

Effects of Ground Cover

In study 1, ground-cover characteristics had a detectable influence only in the clearcut area. Here, infection increased in direct proportion to the amount of bare ground exposed. At seedling age 2, ground cover alone accounted for 82 percent of the difference in infection intensity. The relationship diminished with time until it was no longer significant at age 8.

The proportion of the ground covered by herbaceous vegetation in study 4 was related to severity of infection at seedling age 2. Despite a hardwood canopy on most plots, infection increased as ground cover decreased. The relationship was significant, accounting for 32 percent of the total variation at seedling age 2. By age 4, effects were significant only on poor sites; after age 4 no comparisons were significant.

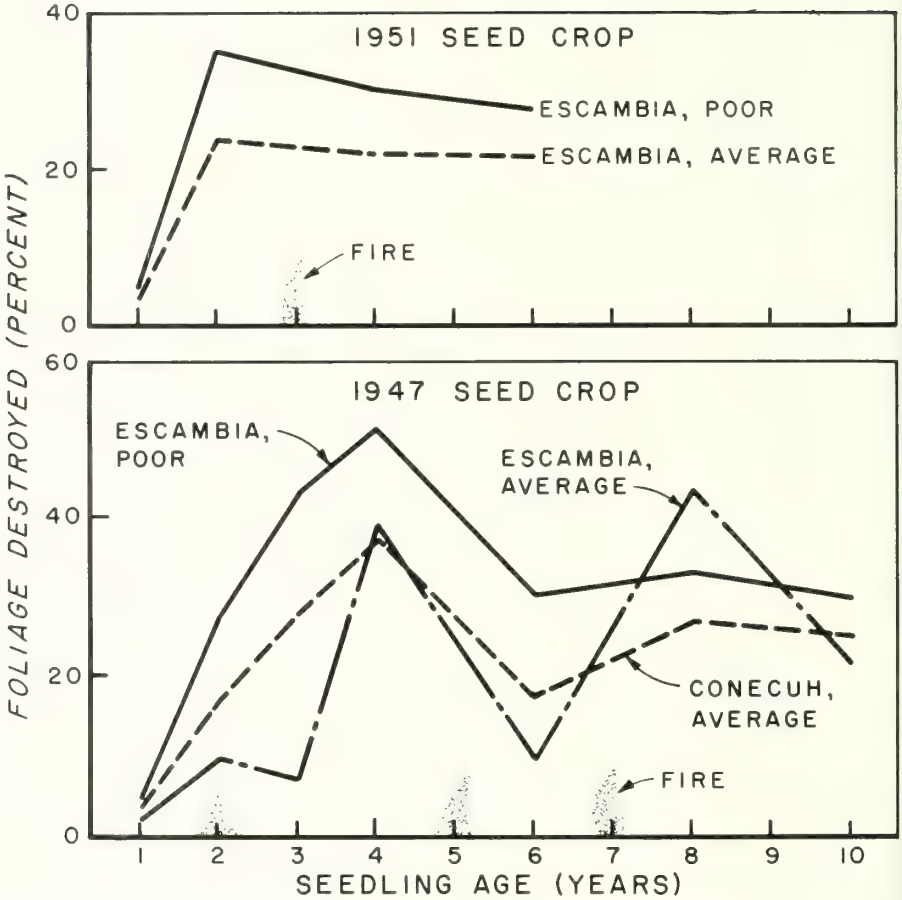

Figure 4.—*Development of infection on poor and average sites (Study 4).*

Ground-cover density may account for part of the site effects, as it was considerably lighter on poor than average sites. Siggers (1932) observed the increase in brown spot on artificially denuded areas and concluded that ground cover partly shields seedlings from the disease until height growth begins.

The ground-cover effect was detected in clearings and under hardwood overstories, but not under pine overstories. The possible effect of pine needle litter was tested on the Escambia Experimental Forest. One hundred grass-stage seedlings in a clearcut area were selected, and half were mulched with needles during the winter. Brown-spot development did not differ between treatments. New foliage destroyed averaged 6 percent for both treatments on June 20, rose to 29 and 30 percent by September 25, and peaked at 53 and 50 percent at the end of January.

Conclusions

These studies indicate that longleaf pine seedlings established under shelterwood overstories of medium densities on Coastal Plain sites will not develop a serious brown-spot problem before the removal cut, even if this cut must be delayed as long as 8 years. Infection normally will not become severe before the end of the second growing season after removal of the pine overstory. By this time, seedlings will generally be large enough to resist burns of moderate intensity, and needle litter and logging slash will have deteriorated to the point where winter fires can safely be prescribed.

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CONE AND SEED CHARACTERISTICS OF FERTILIZED AND UNFERTILIZED LONGLEAF PINES

B. F. McLemore

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1975

Cone and Seed Characteristics Of Fertilized and Unfertilized Longleaf Pines

B. F. McLemore[1]

Fertilizing longleaf pines (Pinus palustris *Mill.) increased cone yields and seed size but did not affect number of seeds per cone, percentage of empty or wormy seed, cone size, initial viability, or keeping quality of seed. Cones per tree, sound seeds per cone, percentage of empties, seed weight, and cone size are characteristics of individual trees. Germinability is not associated with individual trees, nor with seed size, cone size, seeds per cone, or cones per tree. There is no consistent relationship between numbers of cones per tree and seeds per cone.*

Additional keywords: *Pinus palustris*, germination, seed yields.

In agricultural crops the addition of needed fertilizers increases both the quality and quantity of seed, and there is evidence that certain nutrients, especially phosphorus, are translocated from other plant parts into the maturing seeds (Loehwing 1942, Williams 1946). The amount of food in the endosperm is important in determining viability during storage. On consideration of these factors, it seemed possible that summer fertilization might benefit longleaf pine seed trees. A study was therefore made to determine if annual applications of a complete fertilizer, plus trace elements, would affect the quantity and quality of fresh seed and the keeping quality of stored seed. Secondary objectives were to collect cone and seed data useful in the management of seed orchards.

METHODS

In early July of 1957, 44 second-growth longleaf pines were selected in central Louisiana (Rapides Parish). Diameters ranged from 29.5 to 45.2 cm and averaged 38.1 cm, while heights were approximately 20 meters. The trees had large crowns and were about 45 years old. Topography in the area is undulating to gently rolling. Soil is Ruston fine sandy loam with good surface and internal drainage.

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Trees were paired on the basis of their size, proximity, crown volume, and general appearance. Competing hardwoods were removed, and one tree from each pair was randomly selected for five annual applications of fertilizer:

Mineral	*Concentration and source*	*Effective amount*
		Kg
N	33% Ammonium nitrate	1.5
P_2O_5	20% Superphosphate	1.5
K_2O	60% Muriate of potash	1.5
Trace elements		[2]0.5

The fertilizer for each tree was mixed thoroughly and placed in 75 to 100 holes, made with a planting dibble, around the outer edge of the crowns. It was applied between July 21 and August 1 of each year from 1957 through 1961.

To eliminate differences in viability that might be attributed to maturity, cones were collected just as they were ready to open—when their specific gravities were in the 0.70's or low 0.80's. Although collections were made from each tree in 1957, counts were omitted because a hurricane had dislodged many cones. Annual counts were subsequently made from 1958 to 1967.

Four apparently sound, mature cones were picked at random from each tree yearly to determine numbers of full, empty, and wormy seed. Lengths and diameters of these sample cones were recorded from 1961 to 1964.

For the years 1957-1962, all seeds were extracted in a small kiln at approximately 35° C. After being dewinged by hand rubbing and cleaned to 100 percent soundness, they were dried at 35° C to a moisture content of approximately 9 percent. The paired design of the study was maintained throughout drying. Seed from each tree was subdivided into five 200-seed samples for germination tests after 2, 4, 7, and 10 years of storage at 2° C. There was insufficient seed from some trees for testing after the longest periods of storage.

Weight of 200 sound, ovendry seeds was measured for each tree from 1959 through 1967.

Paired "t" tests were used to analyze differences (0.05 level of significance) in cone and seed yields and germination percentages between fertilized and check trees. The arcsin $\sqrt{\text{proportion}}$ transformation was used for all analyses involving germination percentages. Correlation coefficients were computed to evaluate relationships between various cone and seed parameters throughout the study.

RESULTS AND DISCUSSION

Seed Germination

Fertilization had no effect on initial germination, except in 1960 when the controls had a small, unimportant superiority (table 1). Viability was 90

[2] Total amount of a commercial preparation containing 7.8% CuO, 18.4% MnO, 4.5% ZnO, 2.9% Fe_2O_3, and 5.3% B_2O_3.

Table 1.—*Viability of longleaf seed by year of collection and length of storage*

Year and treatment	Initial germination	Germination after storage for—			
		2 years	4 years	7 years	10 years
	Percent				
1957					
Fertilized	89	83	63	50S	24S
Check	91	86	66	63S	40S
1958					
Fertilized	89	95	92	90	84
Check	91	94	94	90	86
1959					
Fertilized	94	92	91	84	93
Check	93	93	92	86	94
1960					
Fertilized	93S[1]	91	91	81	69
Check	96S	91	91	85	60
1961					
Fertilized	74	79	86	76	82
Check	78	84	86	83	87
1962					
Fertilized	91	85	95	92	86S
Check	93	85	96	94	91S

[1] S denotes significant difference (0.05 level) in germination between seed from fertilized and check trees.

percent or greater in all years except 1961, when it averaged 76 percent.

Viability of stored seed from fertilized and check trees differed only for the 1957 crop after 7 and 10 years and for the 1962 crop stored 10 years (table 1). In these three instances, normal germination from check trees was significantly higher than that from fertilized trees; the explanation is unknown. When total germination (normal plus abnormal) was evaluated, however, differences were not significant. The 1957 crop deteriorated more than any others, perhaps because 2 months elapsed between harvesting of cones and storage of seed. In other years this period ranged from 2 to 4 weeks. Previous research has shown that there is a loss in viability during storage when cones (and presumably undried seed, as in this study) are held for 60 days (McLemore 1961).

Seed collected in 1960 declined in viability when stored for 10 years, but differences due to fertilization were not significant. For the other 4 years, decreases in viability after 10 years were small. This result substantiates previous findings that longleaf seed can be held for at least 10 years (Barnett and McLemore 1970).

The 1957 and 1962 crops decreased approximately the same amount during the first 2 years of storage—about 6 percentage points. Analysis indicated that differential performance by individual trees was not a factor. This evi

dence was strengthened by results obtained from 1957 and 1960 seed stored 10 years. Thus, good or poor storability characteristics are not traits of seed from individual trees.

The data did not bear out Toumey and Korstian's (1942) observation that high-quality seed is usually associated with large crops. Germination percentages were not correlated with numbers of cones per tree, sound seeds per cone, percentages of empty seed, seed weights, cone lengths, or cone diameters.

Similarly, seed weights were not related to germination percentages after various periods of storage.

Cone and Seed Production

Cones per tree.—Cone yields varied widely between trees and years. Although overall production was generally higher for fertilized trees, the difference was significant in only 3 of 10 years—1960, 1963, and 1964 (table 2). When all data for the 6-year period from 1959 through 1964 were considered, the fertilized trees produced significantly more cones than the check trees. These results agree with findings by Allen (1953) and Shoulders (1968).

The 1959 crop was the first that could have been influenced by fertilization in 1957, but cone yields did not differ significantly. The 1960 crop was the largest during the 11-year period, and fertilized trees produced 55 percent more cones than check trees. As the last application of fertilizer was made in August 1961, primordia may have been stimulated in 1962. Thus, the 1963 cone crop should have been the last to be affected if carryover effects are discounted. This supposition was strengthened by data from 1965-67, when yields were no longer significantly different.

The study supported Croker's (1964) finding that some longleaf trees consistently produce more cones than others. When comparisons were made of yields from individual trees for each year with the 10-year average for that tree, the r values were significant in 7 of the 10 years for fertilized trees and in 9 of 10 years for check trees.

Wenger (1957) reported that large cone crops of loblolly pine (*Pinus taeda* L.) may reduce the number of flower buds formed during the late summer and early fall, thus curtailing the number of cones produced 2 years later. In comparisons of cone yields between alternate years for the present study, correlation coefficients were generally low and showed significance in only two instances for fertilized trees and in only one for check trees. The general lack of correlation in cone crops from individual trees between alternate years, coupled with the consistent correlations between single years and overall averages, substantiates Wenger's findings.

Seeds per cone.—Fertilization had no effect on number or percentage of seeds per cone—sound, empty, wormy, or total—in any year of observation (table 2). The average of sound seeds per cone for the 44 study trees ranged from 16 in 1966 to 99 in 1967.

	Number					Percent	Grams	Millimeters	
1957									
Fertilized	...	114	82	25	7	22	...	...	...
Check	...	114	84	22	8	20	...	...	...
1958									
Fertilized	127	67	51	15	1	24	...	...	...
Check	183	67	50	15	2	24	...	...	...
1959									
Fertilized	217	109	78	23	8	21	19.2S	...	...
Check	158	107	78	21	8	20	17.3S	...	...
1960									
Fertilized	517S[1]	121	94	24	3	20	16.2	...	...
Check	333S	120	96	21	3	18	15.7	...	...
1961									
Fertilized	271	52	37	11	4	23	16.5S	153	51
Check	198	54	39	10	5	19	14.9S	150	51
1962									
Fertilized	146	103	72	22	9	22	19.2S	173	59
Check	108	99	72	18	9	20	17.9S	167	53
1963									
Fertilized	374S	77	60	16	1	22	16.2	156	50
Check	217S	74	56	16	2	23	16.1	158	52
1964									
Fertilized	264S	63	44	18	1	29	17.1	151	51
Check	158S	63	48	13	2	22	16.6	156	52
1965									
Fertilized	35	77	59	14	4	19	18.4S	...	...
Check	60	80	59	16	5	21	16.7S	...	...
1966									
Fertilized	18	64	18	36	10	54	17.6	...	...
Check	5	56	13	34	9	56	17.1	...	...
1967									
Fertilized	251	126	99	24	3	19	16.4	...	...
Check	274	124	99	21	4	17	15.3	...	...

[1] S denotes significant difference (0.05 level) between fertilized and check trees.

As with cones per tree, there was a definite relationship in seed yields from year to year for individual trees. When numbers of sound seeds per cone from individual trees in adjacent years were compared, correlations were significant in 9 of the 10 pairs of years tested. Thus, trees that yield large or small numbers of seeds per cone in one year can be expected to yield proportionately in the future.

Although number of seeds per cone varied widely between years, the percentage of empty seeds remained fairly constant except in 1966, when the average for all trees was 55 percent. For the other 10 years, percentages ranged from 18 to 26 and averaged 21 (table 2).

Since the annual variation in percentages of empty seed was usually small but differences between trees were great, it appears that some trees consistently have high—or low—percentages of empties. As an example, values from two fertilized trees were:

Crop year	*Tree 15*	*Tree 22*
	— — *Percentage of empties* — —	
1957	4	48
1958	3	30
1959	6	47
1960	5	46
1961	9	38
1962	7	43
1963	11	26
1964	10	59
1965	4	42
1966	43	62
1967	6	23
Average	10	42

In further appraisal, correlation coefficients were computed for individual trees in consecutive years. As was expected, *r* values were high and significant for all years, including 1966, with no differences between fertilized and check trees. This result verifies that percentage of empty seeds is a characteristic of individual trees. The reason is conjectural; fertility cannot explain the variation. DeBarr and Ebel (1974) reported, however, that feeding by the seedbug *Leptoglossus corculus* caused high percentages of empty seed in shortleaf (*Pinus echinata* Mill.) and loblolly pine cones. This predator also feeds on longleaf seed. Differences between trees in susceptibility to the pest may explain the large variation in percentage of empty seeds between trees. Another explanation may be degree of self-pollination. Snyder and Squillace (1966) reported that self-fertilization reduces the yield of sound seed as compared to cross-fertilization, and Bramlett and Popham (1971) developed a

model to express the probability of unsound seed as a function of the number of fertilizations in each ovule and the number of lethal alleles carried by the selfed parent. Although Franklin (1969) reported that selfing of loblolly pine depresses germinability, no relationship was found in the current study between the proportion of empty seed and germinability. Finally, when numbers of cones per tree were compared with percentages of empty seed over the 10-year period, no relationship was apparent.

Correlations between cones per tree and seeds per cone were signicant for fertilized trees in 4 of the 10 years, but in no years for check trees. Perhaps of greater interest is the relationship between years in number of cones and in seed count per cone. Cone production in 1960 exceeded that of any other year, and yields of sound seeds per cone then were surpassed only in 1967. In 1966, by contrast, the number of cones was less than in any other year and yields of sound seeds per cone were also far below average. Aside from these 2 years, no relationship between the cone crop and seed yield was apparent. In the following tabulation, average cone yields per tree are ranked in descending order:

Year	*Cones per tree*	*Sound seeds per cone*
1960	425	95
1963	296	58
1967	262	99
1961	234	38
1964	211	46
1959	188	78
1958	155	50
1962	127	72
1965	48	59
1966	12	16

The computed r value of 0.612 from data in the tabulation was not significant. Wahlenberg (1946) reported that yield of sound longleaf seed per bushel of cones is less in a light than in a heavy cone crop. Wakeley (1954) noted that longleaf may average 50 to 60 sound seeds per cone in good seed years and half as many in poor years. From the data presented here, it appears that the observations of these authors are true only for unusually large or small crops.

Wormy seed.—From 2 to 9 percent of the seeds were infested by larvae of the seedworm *Laspeyresia ingens* each year except in 1966. In that year of low cone and seed yields, damage from the pest rose to 20 percent. Fertilized and check trees suffered equally in all years. Merkel (1967) found that individual slash pines differ in susceptibility to the seedworm *Laspeyresia anaranjada*, but no consistent preference was shown for any particular tree in this study.

On a 10-year average, number of wormy seeds per cone from individual trees was negatively correlated with average number of cones per tree—the

greater the number of cones per tree, the smaller the number of wormy seed per cone. Also significant were the positive correlations between number o wormy seeds per cone and total seeds per cone, and between numbers o wormy and sound seeds per cone. Finally, there was no apparent relationship over a period of 9 years between percentage of wormy seed and seed weights.

Seed weight.—Seed size, as well as shape and coloration, is uniform fo individual trees but varies widely between trees. The weight of 200 sound ovendry seeds from each tree was determined annually from 1959 through 1967. Seeds from fertilized trees were significantly heavier than those from check trees in 4 of the 9 years—1959, 1961, 1962, and 1965 (table 2). In 1960 1963, and 1964, production of cones from fertilized trees was significantly greater than from check trees. Moreover, these were the only years in which significant differences occurred in cone production. It is believed that the reason for lack of significance in seed weights for these 3 years lies in the difference in cone production, since number of cones per tree was negatively correlated with seed weight in 3 years for fertilized trees and in 4 years for check trees. Although heritability, cone size, and fertilization effects are undoubtedly contributing factors, it is concluded that trees with large numbers of cones tend to have light seeds.

Correlations between numbers of sound seeds per cone and seed weights for the 9-year period were not significant for either fertilized or check trees. Moreover, no relationship was apparent between seed weights and percentages of empty or wormy seeds.

Seed weight of individual trees, fertilized or check, was remarkably uniform from year to year, r values ranging from 0.596 to 0.926. Thus, seed from individual trees tends to be consistently large or small. The smallest seeds observed in the study averaged 16,233 per kilogram at 10 percent moisture, while the largest averaged 7,570.

Size of cones.—Cone size was not affected by fertilization. Cone dimensions of individual trees were fairly uniform from year to year (table 2). Correlations of cone lengths and diameters between adjacent years for individual trees were significant in all instances.

Although cones from individual trees are remarkably uniform in size and shape, there is great variation between trees. Correlations between cone length and number of sound seeds per cone were significant for 4 years in which data were available. Cone diameter and sound seeds per cone were significantly correlated in only 2 of the 4 years, but the 4-year average was significant. Veracion (1964) has reported significant correlations between cone size and numbers of seeds per cone for *Pinus insularis,* while Lee and Luo (1957) found positive correlations between size of cones and the number, size, and weight of China fir seeds.

Cone length was not correlated with seed weight. On the other hand, the relationship between cone diameters and seed weights was significant in 3 of

the 4 years for fertilized trees and in 1 year for check trees, indicating a trend for thick cones to yield large seed.

Tree Growth

Diameter (b.h.) of all trees was measured in 1957 and 1962. Fertilized trees averaged a 48-mm increase over the 5-year period, while the increase for check trees was 41 mm—the difference not significant. Height measurements were not taken.

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Xylem Development of Loblolly Pine During Irrigation and Simulated Drought

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and
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Southern Forest Experiment Station
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XYLEM DEVELOPMENT OF LOBLOLLY PINE DURING IRRIGATION AND SIMULATED DROUGHT

David M. Moehring, Charles X Grano, and John R. Bassett[1]

In 27-year-old loblolly pines growing in southeastern Arkansas, soil-water stress reduced the total number of cells produced and appeared to reduce the width of latewood cells. At breast height, transition from earlywood to latewood occurred in early June and was little affected by irrigation but may have been influenced by root injury from trenching. In trees subjected to drought, flat latewood cells first appeared in July; subsequent irrigation stimulated the production of wider latewood cells but not until 3 weeks had passed. In general, the transition from earlywood to latewood was marked by a sharp increase in the time that cells remained in the maturing xylem zone. Trends in wood formation at the base of the live crown were similar to those at breast height but less well defined.

Additional keywords: *Pinus taeda,* soil-water stress, tracheid, wood formation.

Soil moisture status influences formation and development of xylem elements in conifers (Kramer 1964, Zahner 1963, 1968). Larson (1964) suggested that internal water stress directly inhibits production of growth regulators in the crown and thereby modifies cambial activity. Whitmore and Zahner (1966) showed that water stress influences anatomical features of the annual ring of red pine (*Pinus resinosa* Ait.). In work with Scotch pine, *P. sylvestris* L., they (1967) further demonstrated that internal moisture deficit affected tracheid wall metabolism of cambial derivatives independently of regulators produced in the crown.

This paper reports effects of soil-water stress on amount, periodicity, and duration of development of tracheids at breast height (1.4 m aboveground) and at the base of the crown in pulpwood-size loblolly pines (*P. taeda* L.).

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METHODS

A 27-year-old, natural stand near Crossett, Arkansas, was selected for study. The site index is 27.4 m at age 50 years. Basal area averaged 21.8 square meters per hectare. Trees ranged from 25.4 to 30.5 cm in diameter and from 18.0 to 20.4 m in height. Live crown lengths averaged 45 percent of total height. A dense hardwood understory covered the area.

The soil is Grenada silt loam (Glossic Fragiudalf), an imperfectly drained loess underlain by a weak fragipan at a depth of 46 to 61 cm. Available water-holding capacity (0.06 to 15 atm of soil water tension) is estimated to be 30 cm of water in the 0- to 122-cm soil layer.

In April 1965, 15 trees were grouped into five clusters or plots of three trees apiece, and one of five treatments was randomly assigned to each plot:

Drought (D). Continuous surface drought, May through December. Plot trenched and sheltered from rain by polyethylene cover.

Irrigation (I). Surface 30 cm of soil maintained near field capacity by supplemental irrigation, May through December. Plot trenched and irrigated weekly by rotary sprinklers.

Drought + Irrigation (DI). Drought imposed from May 1 to July 15 by polyethylene cover; irrigation from July 16 through December. Plot trenched.

Trenched Control (TC). Natural rainfall; plot trenched.

Untrenched Control (UC). Natural rainfall; plot not trenched.

Trenches were 46 cm wide by 122 cm deep, and at least 3 m from the boles of study trees. During imposed droughts the polyethylene sheets shunted rainwater into the trench; a catchment basin was dug in the lowest part of the trench to take the runoff.

Water content in the 0- to 122-cm soil layer was measured weekly with a neutron probe. Rain was recorded daily at an adjacent weather station. Irrigation water was measured with rain gages.

Diameter growth at breast height and at the base of the crown of each tree was measured weekly with aluminum-band dendrometers to the nearest 0.2 mm. To study tracheid development at both bole positions, wood samples (1 cm wide x 2 cm long x 1 cm thick) extending inward 2 to 3 growth rings were extracted with a chisel at 1- to 4-week intervals from May 10, 1965, to January 24, 1966. The samples were immediately fixed in formalin-acetic acid-alcohol, then infiltrated with celloidin (Sass 1958). To detect lignification, transverse sections 20 to 30μ thick were cut and subjected to a phloroglucin-hydrochloric acid solution, which turns lignified cell walls red-violet. Transverse sections 15 to 25μ thick were cut and stained with safranin and fast green to help identify developing zones in the newly differentiating xylem. Although many samples were extracted from a small area on the boles of all trees, no abnormalities in wood formation were apparent.

Three zones of differentiating xylem (Wilson et al. 1966) were studied: 1. Dividing and radially enlarging xylem—a zone composed of (a) flattened, thin-walled cambium and neighboring xylem cells which are actively dividing but not enlarging in radial diameter, and (b) thin-walled cells enlarging in radial diameter but not yet showing lignification and thickening of the wall. 2. Maturing xylem—cells that have attained maximum radial enlargement but whose cytoplasm is still present and whose secondary walls are still thickening. 3. Mature xylem—cells that have completed development and are now a portion of the permanent wood layer. Mature xylem elements were further designated as earlywood or latewood tracheids according to Mork's classification (Smith and Wilsie 1961) or as flat latewood tracheids (Zahner et al. 1964).

The number of cells in each zone was counted in three continuous radial files in each wood sample. A seasonal trend of xylem development during 1965 was synthesized for individual trees by plotting the average count for each zone against the sample date and drawing a freehand curve through the points. Treatment trends were established by averaging the data of the three trees per plot. Because treatments were not replicated, inferences about interactions cannot be tested statistically. Main-effect differences in cell production by treatment and by bole position were tested by two-way variance analysis of plot averages and Tukey tests of simple contrasts.

RESULTS

Soil Water Regimes

Over the study period, the irrigated plot contained approximately three times as much water as the drought plot (17 to 27 cm more, fig. 1). The trenched control plot contained up to 12 cm more water than the drought plot, primarily in the surface 30 cm. Soil-water content in the drought-plus-irrigation plot was 2 to 8 cm more than in the continuous-drought plot through mid-July and about the same as that of the irrigated plot thereafter. Trees in the drought plot utilized water from below 122 cm, but not in sufficient quantities to maintain rapid cambial activity.

The desired soil-water conditions were maintained until September 10, when rains from a hurricane overflowed the catchment basin and accumulated in the open trench around the drought plot. The added water increased cambial activity. Cumulative diameter growth at breast height and at the base of the crown is shown in figure 2.

Amount of Cell Production

Drought appears to have reduced cell production at breast height. On drought plots the total number and radial width of tracheids during treatment in 1965 averaged 55 percent as great as before treatment in 1963-64 (tables 1 and 2); on other plots the number and width of tracheids was not altered much by treatment. Width of latewood cells appeared to be reduced by trenching. In trenched controls, cells averaged 73 percent as wide in 1965 as 1963-64, whereas they averaged 107 percent as wide in untrenched controls (table 2).

More cells, particularly earlywood cells (an average of 36 per radial file, as compared to 30), were produced at the base of the crown than at breast height (table 3). Tukey's method was used to test comparisons between main effects; treatments underscored by the same line did not differ

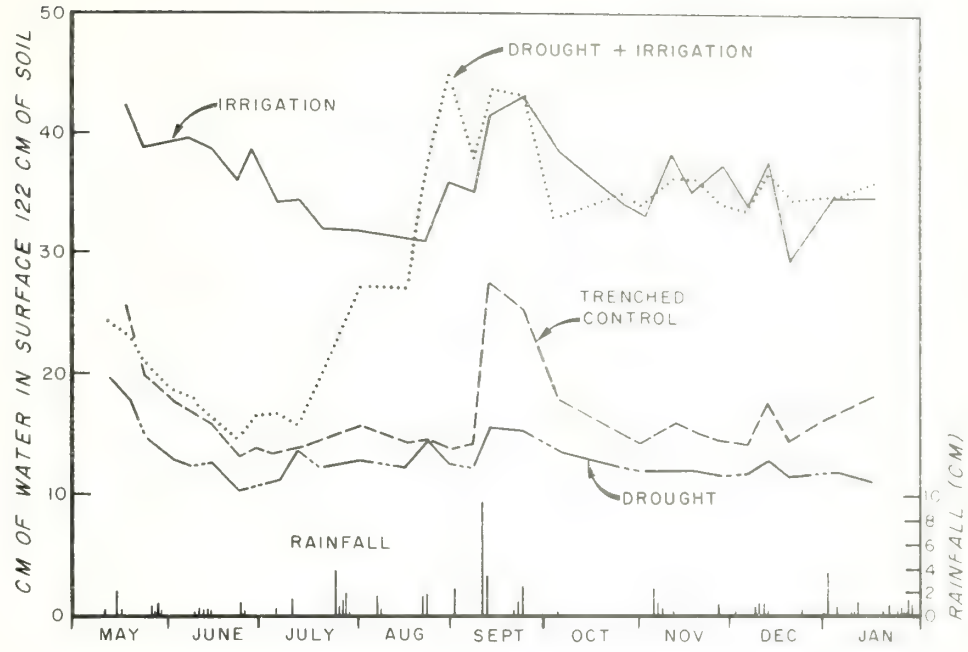

Figure 1.—*Soil-water content and daily rainfall, May 1965 to January 1966.*

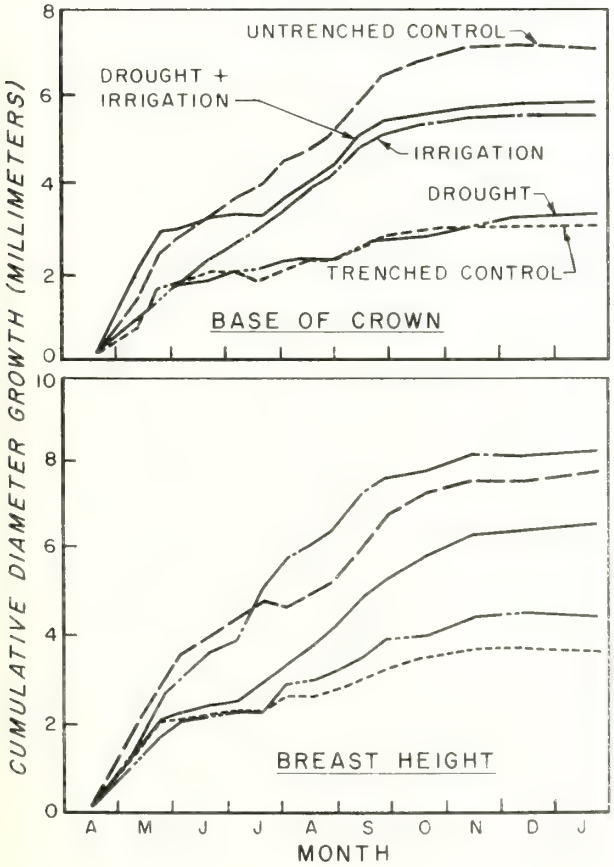

Figure 2.—*Cumulative diameter growth from April 1965 to January 1966.*

significantly (0.05 level):

Earlywood cell production					Total cell production				
UC	DI	I	D	TC	UC	I	DI	TC	D

All 12 trenched trees produced significantly fewer earlywood cells than the three untrenched controls, and trenched controls had significantly fewer earlywood cells than drought-irrigated trees. Latewood was too variable in our small sample to show significant differences even though drought trees developed less than half as many latewood cells at the crown base as at breast height (19 versus 43 cells).

Periodicity of Cell Production

Numbers of cells produced at breast height in 1965 are graphed in figure 3. In all trees cambial division had begun before the first wood samples were extracted on May 10 (23 to 31 cells had already formed) and continued into November. In drought trees, for example, 23 earlywood cells had been laid down by May 10, of which 6 were dividing and radially enlarging, 5 were maturing, and 12 were mature xylem. A similar pattern of cambial division was evident at the base of the crown (not illustrated). While the freehand curves do not reveal the variability of data, we think they illustrate

TABLE 1.—*Mean number and percentage of xylem elements for 1963-64 and 1965 annual wood layers at breast height*

Treatment	Earlywood			Latewood			Earlywood and latewood		
	1963-64	1965	1965 / 1963-64	1963-64	1965	1965 / 1963-64	1963-64	1965	1965 / 1963-64
	No.		*Pct.*	*No.*		*Pct.*	*No.*		*Pct.*
Drought	53	26	49	72	43	60	125	69	55
Irrigation	40	31	78	58	57	98	98	88	90
Drought + irrigation	33	29	88	53	54	102	86	83	96
Trenched control	19	24	126	43	37	86	62	61	98
Untrenched control	49	40	82	61	55	90	110	95	86

TABLE 2.—*Mean radial width of xylem elements for 1963-64 and 1965 annual wood layers at breast height*

Treatment	Earlywood			Latewood			Earlywood and latewood		
	1963-64	1965	1965 / 1963-64	1963-64	1965	1965 / 1963-64	1963-64	1965	1965 / 1963-64
	Mm.		*Pct.*	*Mm.*		*Pct.*	*Mm.*		*Pct.*
Drought	2.2	1.2	55	2.0	1.1	55	4.2	2.3	55
Irrigation	1.6	1.5	94	1.5	1.5	100	3.1	3.0	97
Drought + irrigation	1.5	1.4	93	1.3	1.5	115	2.8	2.9	104
Trenched control	1.0	1.1	110	1.1	.8	73	2.1	1.9	90
Untrenched control	2.3	2.1	91	1.5	1.6	107	3.8	3.7	98

TABLE 3.—*Tracheids per radial file, at breast height and base of live crown*

Treatment	Earlywood		Latewood		Total	
	At b.h.	At base of crown	At b.h.	At base of crown	At b.h.	At base of crown
	Number					
Drought	26	35	43	19	69	54
Irrigation	31	35	57	64	88	99
Drought + irrigation	29	39	54	50	83	89
Trenched control	24	28	37	44	61	72
Untrenched control	40	46	55	62	95	108

the general pattern of cell production as affected by treatments.

At breast height, Mork latewood cells first appeared in the maturing xylem between June 1 to 24, and flat latewood cells appeared as early as July 2 in trees subjected to drought:

Treatment	Initiation of cells	
	Mork latewood	Flat latewood
Drought	June 12	July 18, Nov. 4
Irrigation	June 14	Oct. 16
Drought + irrigation	June 5	July 2, Nov. 4
Trenched control	June 1	Nov. 4
Untrenched control	June 24	Nov. 11

Trenching seemed to have an effect, because latewood cells appeared 1 to 3 weeks sooner in all 12 trenched trees than in the three untrenched trees.

At breast height, Mork latewood cells first appeared in the permanent wood layer 2 to 3 weeks after becoming maturing xylem; at the base of the crown the transition occurred, on the average, 1 to 3 weeks later than at breast height. Date of latewood initiation varied widely among trees within plots.

Throughout the growing season the zone of dividing and radially enlarging xylem at breast height ranged from four to eight cells wide in all trees. In drought and drought-irrigated trees this zone was four to six cells wide, but after reduction of soil-water stress by irrigation and the hurricane it increased one to three cells in width, equaling the number of cells in the same zone of irrigated trees.

When soil-water stress was low, cell formation progressed at a uniform rate from May to October, and rates during summer often exceeded those in spring. Cell production diminished rapidly with increasing and prolonged soil-water stress. During July and August, for example, the rate at low stress was four times that at high stress, and the number of cells in the differentiating xylem of irrigated trees was 2½ times that of drought trees. When stress was changed quickly from high to low, the rate increased markedly but not until some 3 weeks later. In drought-irrigated trees, for example, the maturing xylem averaged three cells wide on July 26 (10 days after irrigation began) and 12 cells wide on August 16 (fig. 3). In drought trees, the maturing zone was four

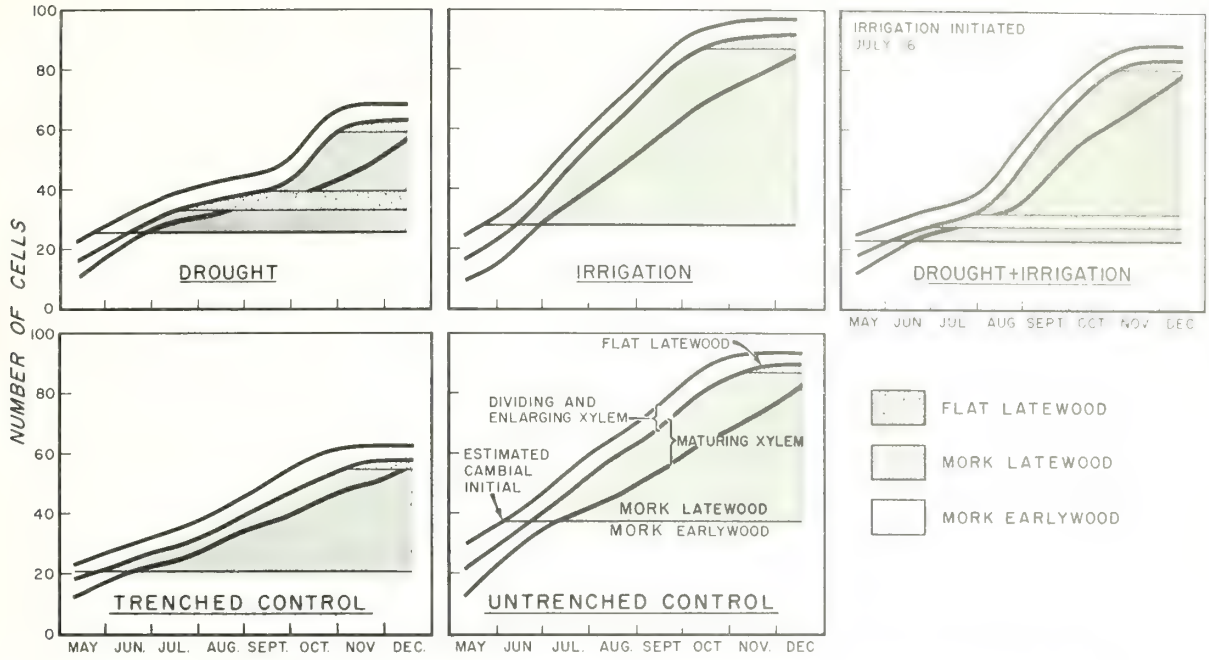

Figure 3.—*Curves of the seasonal development of the various zones of maturing tracheids in the xylem ring at breast height, in terms of the number of cells. The smoothed, freehand curves connect average number of cells for three trees, as determined by counts made on the 7th and 21st day of each month. As an example, the graph for untrenched control trees is interpreted as follows: Flat latewood cells (Zahner et al. 1964) first appeared in the wood sample extracted on November 11. Mork latewood cells first appeared in maturing xylem layer on June 23; these cells first appeared in the permanent wood layer on July 12, the date corresponding to the intersection of the earlywood-latewood zone boundary and the lower boundary of the maturing-xylem zone. This graphical technique, modeled after Whitmore and Zahner (1966), is valid only if all tracheids arise from the cambium initial (Bannan 1962, Wilson 1966).*

cells wide on September 27 (16 days after the hurricane) and 12 to 15 cells wide on October 18. In contrast, a similar spurt in cell production was not found at the base of the crown. In Monterey pines (*P. radiata* D. Don) similar in size to our loblolly pines, Shepherd (1964) detected resumption of rapid cell formation at breast height within a week after reduction of soil-water stress.

At breast height the number of cells in the zone of maturing xylem generally decreased from early May to late June, then increased until middle to late October. At its maximum, the zone consisted of approximately eight cells in trenched controls and 16 to 19 cells in all other trees. In irrigated and untrenched controls the zone began to expand earlier in June than in the other trees. At the base of the crown the zone contained a somewhat, but inconsistently, larger number of cells than at breast height.

Duration of Xylem Development

Time spent by cells in the differentiating xylem layer was estimated biweekly with Whitmore and Zahner's (1966) graphic-reconstruction technique. The uppermost curves in figure 3 represent the position of the estimated cambial initial plotted over time. Zones of dividing and enlarging xylem and of maturing xylem were scaled from this curve.

In drought trees, which produced proportionately fewer cells than other trees during 1965 as compared with 1963-64 (55 percent, table 1), the time spent by cells in the dividing and radially enlarging stage was greater than in other trees, ranging from 3 weeks under low soil-water stress in May and September to 8 weeks under high stress in July:

Treatment	Low stress	High stress
	— *Weeks* —	
Drought	3	8
Irrigation		
Drought + irrigation		2
Trenched control	1	
Untrenched control	3	

In drought-irrigated trees, cells divided and enlarged for approximately 6 weeks during May and June

while enduring drought but for only 2 weeks in August and September while benefiting from irrigation. Cells of irrigated-only trees divided and enlarged for 4 weeks during May but for only 2 weeks thereafter. Untrenched controls exhibited a uniform pattern of cell division and enlargement, averaging approximately 3 weeks during the entire growing season. Trenched controls responded similarly, except that the period of division and enlargement averaged 4 weeks.

In all treatments, time spent by latewood cells in the maturing xylem increased gradually throughout the growing season, ranging from 2 weeks in early May to 10 weeks in late September (fig. 4):

Treatment	May	Sept.
	— *Weeks* —	
Drought and drought + irrigation	2.0	6
Irrigation	2.5	10
Trenched control	2.5	6
Untrenched control	2.5	8

In irrigated trees and untrenched controls, latewood cells remained in the maturing xylem approximately 3½ weeks longer than in trees subjected to trenching and drought. In all treatments new cells were evident in the maturing xylem on December 13 but not on January 24. Addition of new cells to the xylem by the cambium initial had ceased prior to November 15.

DISCUSSION AND CONCLUSIONS

Our finding that number and width of earlywood and latewood cells were reduced by drought agrees with the results of others (Foil 1961, Shepherd 1964, Smith and Wilsie 1961, Buijtenen 1958, Howe 1968). Drought affects cell production through its influence on tree-water stress, which reduces crown development. Larson (1964) has hypothesized that diminished crown activity restricts production of auxin, and thus reduces photosynthesis and impairs transport of carbohydrates to the cambial region.

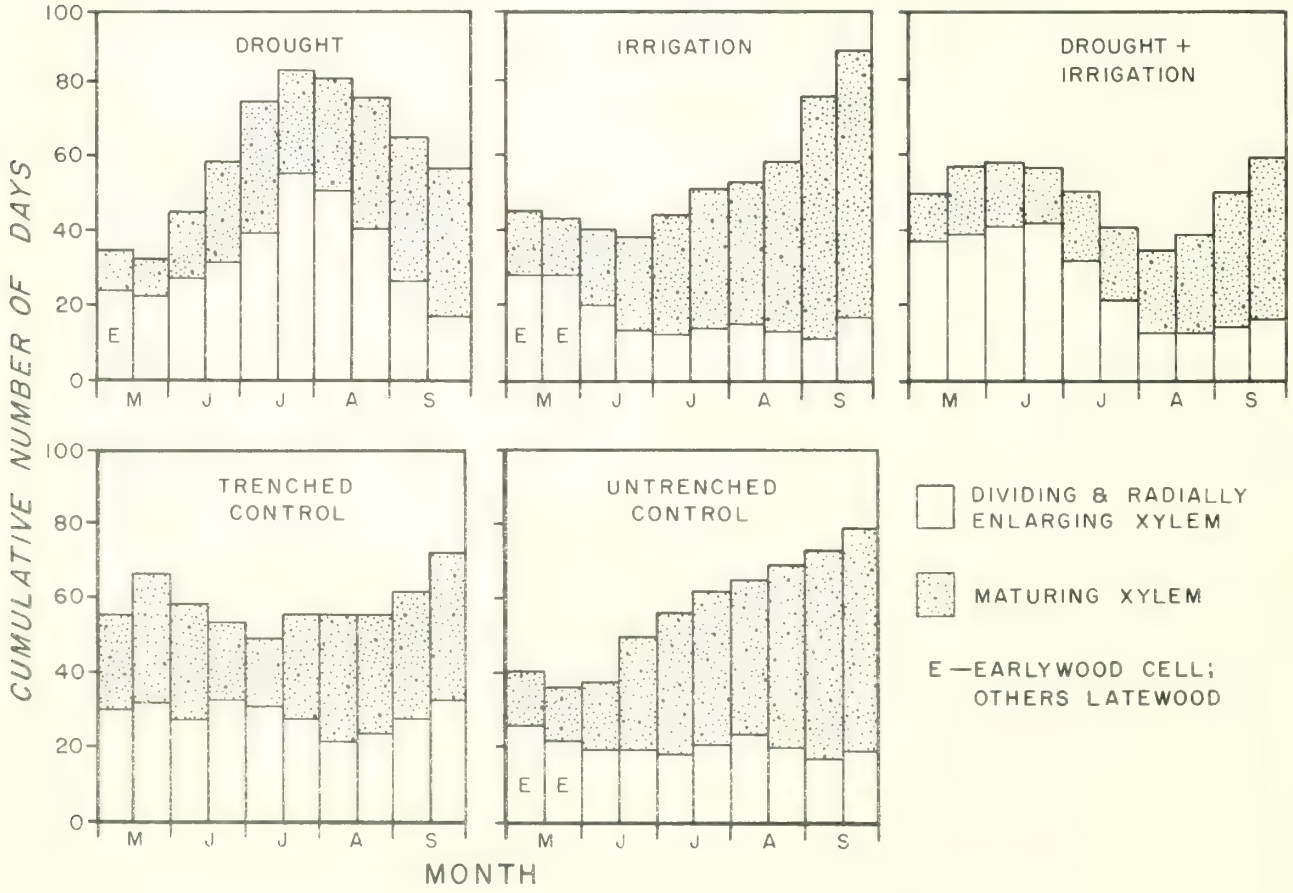

Figure 4.—*Time spent by cells originating after May 10 in the dividing and radially enlarging xylem and in the maturing xylem zones.*

Our results indirectly support this hypothesis.

Fewer earlywood cells and narrower latewood cells were produced in trenched than in untrenched controls. Trenching undoubtedly reduces the ability of trees to absorb moisture and, because some trees were closer to the edges of plots than others, the degree of root damage varied. Nevertheless, cell production in the trenched trees increased sharply after irrigation and the hurricane. The damage from trenching therefore was not so severe that it overcame the effects of moisture controls.

In general, the transition from earlywood to latewood tracheids was marked by a sharp increase in the time cells remained in the maturing xylem layer. Earlywood cells originating after May 10 (in drought, irrigated, and untrenched control trees) remained in this stage less than 2 weeks (fig. 4). Cells that qualified as latewood remained 2½ to 10 weeks, considerably longer than the 2½ to 4 weeks reported for red pine (Whitmore and Zahner 1966). Other research (Zahner et al. 1964) has shown that irrigation delays initiation of latewood. In our study, transition from earlywood to Mork latewood was little affected by irrigation; the transition occurred earlier in the 12 trenched trees than in the three untrenched trees presumably because trenching intensified internal water stress. In the six trees subjected to drought, flat latewood cells appeared in a narrow band in July, but subsequent relief of water stress stimulated production of wider latewood cells. Our results support those of other investigators who have reported that increases in soil-water availability accelerate cell production during latewood formation (Foil 1961, Howe 1968, Shepherd 1964).

In the six trees subjected to drought, cells enlarged less radially as soil-water stress increased, so that a narrow band of flat latewood cells formed prior to relief. In individual trees, these cells increased by as much as 50 percent in radial dimension within 3 weeks following resupply of water, but they were nevertheless classified as latewood by Mork's definition. Whitmore and Zahner (1966) emphasize that, independent of auxin, moisture stress affects cell expansion through photosynthesis and phloem transport; the mechanism is either a reduction in carbohydrate nutrition, reduction in growth substances transported from the crown, or direct physical retardation of cell division and enlargement. These authors believe that earlywood cells result when xylem derivatives become widely separated from the phloem and consequently are subjected to increasing competition for wall substrate. In our study, secondary cell wall synthesis was not greatly reduced even though cells that developed after the drought were rapidly separated from the phloem. The cells that increased their radial width after the drought were dividing and radially enlarging prior to reduction of soil-water stress. Thus they apparently retained the capacity to enlarge radially.

The length of time loblolly pine tracheids spent in the dividing and enlarging stage decreased as rate of cell division increased. Fewer and narrower tracheids were formed under drought than with ample moisture, and they took up to 6 weeks longer to enter the stage of maturing xylem. These observations agree with those of Whitmore and Zahner (1966) on red pine. High water stress may indirectly limit synthesis and transport of substances, thereby affecting cell wall plasticity, or it may directly reduce turgor, thus slowing enlargement. Cells initiated during stress appear to retain the capacity for expansion much longer than do nonstressed cells. Shepherd (1964) observed such a relation in Monterey pine.

Width of the zone of dividing and radially enlarging cells appears to be more uniform in loblolly than in red pine. Number of red pine cells decreased steadily during the growing season on both irrigated and drought plots (Whitmore and Zahner 1966, fig. 3). If auxins promote radial expansion of xylem cells, as some researchers believe, perhaps multiple flushing and consequent needle elongation maintain a constant amount of auxin in the cambium of loblolly pine. In red pine, shoot elongation is over by mid-June.

Width of the zone of maturing xylem, and time spent by cells in it, increased during the growing season — a pattern similar to that exhibited by red pine. In Monterey pine Skene (1969) has found that, late in the growing season, cell wall thickening lasts 8 to 10 weeks. In our study, time spent in this stage was inversely related to soil-water stress but lasted up to 10 weeks in contrast to a maximum of 4 weeks for red pine. Late in the growing season this zone narrowed more rapidly in red than in loblolly pine. Cells in the maturing xylem of loblolly pine retained cytoplasm until late December. The life of tracheid cells is apparently longer in loblolly pine than red pine.

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Additional keywords: *Pinus taeda*, soil-water stress, tracheid, wood formation.

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Composition and Digestibility of Deer Browse in Southern Forests

Henry L. Short
Robert M. Blair
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Southern Forest Experiment Station
Forest Service
U.S. Department of Agriculture

1975

COMPOSITION AND DIGESTIBILITY OF DEER BROWSE IN SOUTHERN FORESTS

Henry L. Short,[1] Robert M. Blair,[2] and E. A. Epps, Jr.[3]

Leaves and twigs from browse plants important as deer foods in the loblolly-shortleaf pine forests of the South were subjected to nutrient analyses and in vivo *microdigestion by the nylon bag technique. Twigs were most succulent, nutritious, and digestible during spring while growing rapidly. After they matured, usually in early summer, they were of increased fiber content and reduced digestibility. Quality and digestibility of mature twigs declined as distance from the twig tip increased. Browse leaves from evergreen species retained their good forage quality and digestibility throughout the year. Leaves of deciduous species usually lost their quality and digestibility after abscission.*

Additional keywords: Forage quality, nutrients, ruminants, *in vivo* microdigestion, woody twigs, wildlife foods.

The characteristic growth pattern of woody browse plants in the South is accompanied by major changes in nutrient composition and digestibility. Growth generally is rapid for a short time after buds burst in early spring. Initially the woody shoot is succulent and has characteristics not unlike those of herbaceous vegetation (Cushwa *et al.* 1970). This state is transitory, however, because shoot growth proceeds rapidly and may be essentially completed by late spring or early summer (Halls and Alcaniz 1972). As the rate of twig elongation slows, cell walls thicken and lignify (Isenberg 1963), and cellular protoplasm is lost (Wort 1962). Coincident with the slowing and hardening of twig growth is a decrease in digestibility (Short *et al.* 1972).

This paper describes seasonal changes in nutrient composition and digestibility for leaves and twigs of browse species common in southern forests where shortleaf and loblolly pines grow in mixture with hardwoods. The species are identified in table 1. While general seasonal trends in browse quality are well known, the data published here are more specific and detailed than any other on record for this forest type.

METHODS

Browse tissue was collected from the Stephen F. Austin Experimental Forest near Nacogdoches, Texas, during spring (April), summer (August), and autumn (October) of 1970, and during the winter of 1971 (January) (table 1). Samples were taken within the 5-foot deer feeding zone on an area that had been prescribe-burned during January 1970. Each sample was a composite from the current growth of several plants.

Four-inch terminal twigs were taken from species or species groups: Alabama supplejack, common and saw greenbriers, grapes, common trumpetcreeper, and peppervine. Two-inch terminals were collected from the other species. Leaves, when present, were separated from the twigs. Dried and fallen leaves of deciduous species were collected from the ground during winter.

Tissues were dried at 40°C, ground in a Wiley mill, and analyzed for silica, neutral detergent

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[3] Chief Chemist, Feed and Fertilizer Laboratory, Louisiana Agricultural Experiment Station, Louisiana State University, Baton Rouge.

Table 1.—*Composition and digestibility of twigs from 20 browse species collected in east Texas at the four seasons*

Species	Season collected	Dry matter	Crude protein	Crude fiber	Phosphorus	CWC[1]	ADF	ADL	Silica	Hemicellulose	Cellulose	Digestibility	
												NBDMD	ETDMD
		Percent of green weight	— — — — — — — — — — *Percent of ovendry weight* — — — — — — — — — —										
Loblolly and shortleaf pine, *Pinus taeda* L. and *P. echinata* Mill.	Spring	28.2	8.2	30.5	0.18	51.1	35.8	16.8	0.14	15.3	19.0	60.3	55.8
	Summer	45.0	3.7	43.8	.08	66.8	55.4	27.5	.17	11.4	27.9	42.2	41.6
	Autumn	45.3	5.2	40.4	.12	61.3	51.0	25.0	.03	10.3	26.0	42.6	46.5
	Winter	49.5	6.2	36.6	.09	56.5	46.4	23.0	.22	10.1	23.4	49.3	50.3
Common and saw greenbriers, *Smilax rotundifolia* L. and *S. bona-nox* L.	Spring	12.7	31.7	16.0	.69	30.7	18.7	5.6	.09	12.0	13.1	87.5	77.4
	Summer	40.4	6.9	57.9	.13	77.5	62.4	24.7	.06	15.1	37.7	18.0	38.5
	Autumn	44.2	7.0	59.0	.11	78.7	61.3	23.9	.08	17.4	37.4	18.2	38.0
	Winter	42.3	8.1	55.0	.13	76.0	55.7	22.0	1.05	20.3	33.7	20.9	36.6
Willow oak, *Quercus phellos* L.	Spring	32.5	10.7	37.4	.25	56.3	42.2	13.5	.25	14.1	28.7	51.9	58.9
	Summer	53.8	4.6	43.6	.12	62.5	52.6	18.5	.17	9.9	34.1	37.4	52.6
	Autumn	63.1	4.9	41.0	.08	68.5	50.6	20.1	.02	17.9	30.5	35.8	45.3
	Winter	61.9	6.6	40.9	.11	65.3	50.6	19.9	.19	14.7	30.7	37.9	48.0
Water oak, *Q. nigra* L.	Spring	26.7	10.4	33.4	.24	50.8	37.7	10.0	.08	13.1	27.7	55.3	66.0
	Summer	56.5	4.2	41.7	.13	64.3	53.2	19.1	.11	11.1	34.1	38.6	50.8
	Autumn	56.6	4.9	41.5	.09	67.5	50.7	19.5	.03	16.8	31.2	35.3	46.9
	Winter	58.5	5.9	41.0	.09	63.9	48.1	18.7	.21	15.8	29.4	40.2	49.4
Winged elm, *Ulmus alata* Michx.	Spring	30.8	18.2	25.3	.35	38.9	30.8	7.9	.48	8.1	22.9	78.3	73.9
	Summer	59.0	5.4	41.9	.10	64.5	55.4	22.8	.84	9.1	32.6	44.9	47.6
	Autumn	61.1	5.8	38.0	.11	62.3	52.9	22.7	.81	9.4	30.2	42.0	48.5
	Winter	60.8	7.7	39.6	.08	62.4	53.2	22.9	1.16	9.2	30.3	47.0	44.8
Common sassafras, *Sassafras albidum* (Nutt.) Nees	Spring	15.8	28.6	15.9	.71	39.1	33.1	16.0	.09	6.0	17.1	53.7	65.3
	Summer	47.1	4.2	42.8	.08	62.0	50.1	16.6	.03	11.9	33.5	43.8	54.2
	Autumn	55.1	6.2	36.0	.08	62.7	42.6	14.2	.03	20.1	28.4	45.3	53.6
	Winter	56.3	6.0	39.5	.07	58.9	44.8	15.7	.04	14.1	29.1	50.7	55.3
American sweetgum, *Liquidambar styraciflua* L.	Spring	19.6	14.5	14.6	.39	28.3	27.6	11.5	.12	.7	16.1	77.6	75.8
	Summer	38.8	3.7	27.5	.08	48.7	41.7	12.4	.23	7.0	29.3	54.2	65.4
	Autumn	43.0	5.6	26.4	.10	45.8	37.3	13.7	.30	8.5	23.6	56.3	64.0
	Winter	43.0	6.6	34.1	.10	51.9	42.7	15.5	.47	9.2	27.2	51.3	59.7
Hawthorns, *Crataegus* spp.	Spring	33.1	13.6	15.8	.34	26.3	20.9	6.1	.08	5.4	14.8	84.2	80.6
	Summer	61.4	4.3	34.9	.08	57.5	46.3	20.2	.04	11.2	26.1	39.7	52.0
	Autumn	58.4	5.4	31.4	.09	59.6	45.3	19.7	.05	14.3	25.6	41.9	50.3
	Winter	54.4	7.5	32.3	.16	60.0	44.5	20.3	.23	15.5	24.2	45.1	49.0
American and flatwoods plum, *Prunus americana* Marsh. and *P. umbellata* Ell.	Spring	21.9	24.1	10.8	.17	19.2	15.7	5.3	.11	3.5	10.4	89.2	84.3
	Summer	61.2	5.0	36.8	.07	59.2	50.4	20.0	.08	8.8	30.4	38.1	52.5
	Autumn	61.8	5.7	32.6	.07	63.3	49.6	22.9	.02	13.7	26.7	39.0	46.1
	Winter	58.6	7.4	32.7	.12	61.2	52.5	26.1	4.71	8.7	26.4	37.6	32.1
Blackberry, *Rubus* spp.	Spring	19.9	20.5	14.2	.47	21.5	16.8	3.5	.27	4.7	13.3	86.7	86.2
	Summer	42.6	6.1	36.2	.13	53.4	44.0	14.2	.13	9.4	29.8	36.1	60.8
	Autumn	47.5	6.9	36.4	.14	54.8	42.4	14.1	.02	12.4	28.3	39.9	59.2
	Winter	52.7	8.3	36.1	.12	52.2	40.1	13.2	.11	12.1	26.9	49.9	61.2
Yaupon, *Ilex vomitoria* Ait.	Spring	26.9	12.1	24.1	.18	37.1	31.5	11.4	.14	5.6	20.1	71.0	70.7
	Summer	57.2	4.1	48.9	.08	71.4	63.4	18.1	.15	8.0	45.3	26.5	51.2
	Autumn	55.1	4.5	48.8	.08	70.3	57.4	17.0	.07	12.9	40.4	32.1	51.0
	Winter	59.0	4.8	43.8	.06	69.0	53.2	16.0	.17	15.8	37.2	31.5	51.5
Alabama supplejack, *Berchemia scandens* (Hill) K. Koch	Spring	23.8	9.7	31.7	.18	47.3	39.9	14.5	.11	7.4	25.4	64.3	63.1
	Summer	49.8	4.0	42.2	.08	59.0	54.1	20.8	.09	4.9	33.3	31.8	53.3
	Autumn	60.8	4.8	41.3	.06	70.6	51.5	24.0	.04	19.1	27.5	29.0	39.9
	Winter	56.8	5.6	42.8	.07	63.6	51.6	27.4	.03	12.0	24.2	26.4	42.8
Peppervine, *Ampelopsis arborea* (L.) Koehne	Spring	18.3	16.1	16.6	.59	26.1	22.6	5.6	.17	3.5	17.0	80.9	82.2
	Summer	34.0	5.1	30.4	.11	47.7	40.3	12.9	.11	7.4	27.4	51.1	64.9
	Autumn	35.6	5.2	34.9	.12	54.1	46.4	16.1	.03	7.7	30.3	43.6	58.9
	Winter	52.7	5.0	43.8	.08	64.8	54.1	21.6	.04	10.7	32.5	30.8	48.1
Grapes, *Vitis* spp.	Spring	12.8	21.2	15.7	.59	33.4	28.6	12.1	.20	4.8	16.5	72.0	71.6
	Summer	27.0	4.6	38.8	.14	56.2	47.5	11.9	.23	8.7	35.6	52.5	63.7
	Autumn	32.7	3.9	40.8	.11	60.7	52.9	14.9	.20	7.8	38.0	48.0	58.5
	Winter	62.5	4.7	48.4	.09	71.7	59.9	22.3	.42	11.8	37.6	27.5	44.5

Table 1.—*Composition and digestibility of twigs from 20 browse species collected [illegible]*

Species	Season collected	Dry matter	Crude protein	Crude fiber	Phosphorus	CWC	ADF	ADL	Silica	Hemicellulose	Cellulose	Digestibility NBDMD	Digestibility ETDMD
		Percent of green weight				*Percent of ovendry weight*[1]							
Flowering dogwood, *Cornus florida* L.	Spring	23.8	11.0	19.9	.21	28.6	24.8	7.0	.08	3.8	17.8	78.6	[illegible]
	Summer	36.4	4.7	29.1	.08	40.3	35.6	12.1	.10	4.7	23.5	64.1	[illegible]
	Autumn	43.2	6.4	26.4	.10	38.5	33.0	10.9	.02	5.5	22.1	66.3	70.8
	Winter	44.2	7.4	26.5	.11	40.9	33.9	11.9	.92	7.0	22.0	66.2	68.3
Black tupelo, *Nyssa sylvatica* Marsh.	Spring	15.4	10.0	20.5	.22	37.1	26.9	5.2	.31	10.2	21.7	83.1	78.6
	Summer	48.3	3.8	35.2	.07	61.2	48.2	16.2	.08	13.0	32.0	43.1	54.5
	Autumn	54.9	4.9	36.5	.06	63.4	46.4	16.5	.06	17.0	29.9	38.6	51.7
	Winter	47.2	5.5	38.7	.12	60.0	48.6	17.0	.09	11.4	31.6	44.4	54.5
American beautyberry, *Callicarpa americana* L.	Spring	15.3	24.5	16.8	.39	39.7	30.0	10.4	1.42	9.7	19.6	84.8	85.1
	Summer	44.2	6.3	41.8	.12	66.7	53.0	13.1	.23	13.7	39.9	36.4	57.6
	Autumn	52.8	7.7	37.2	.10	61.4	46.4	13.3	.14	15.0	33.1	42.5	57.7
	Winter	60.0	8.3	35.2	.10	56.9	43.9	26.1	.26	13.0	17.8	11.6	46.1
Common trumpetcreeper, *Campsis radicans* (L.) Seem.	Spring	14.6	21.8	18.5	.59	35.5	27.2	7.7	.11	8.3	19.5	79.4	74.8
	Summer	47.2	4.3	47.9	.09	68.0	54.6	16.4	.25	13.4	38.2	35.1	52.2
	Autumn	47.6	5.3	43.5	.10	66.5	49.8	17.8	.16	16.7	32.0	33.3	49.3
	Winter	56.3	5.8	44.5	.12	69.6	54.1	20.2	.04	15.5	33.9	32.7	46.4
Japanese honeysuckle, *Lonicera japonica* Thunb.	Spring	17.1	10.6	26.3	.32	41.2	29.6	8.3	.12	11.6	21.3	70.6	71.2
	Summer	46.4	4.8	41.7	.13	66.4	48.2	15.0	.13	18.2	33.2	35.0	52.5
	Autumn	43.0	4.7	45.4	.08	72.0	52.9	18.5	.21	19.1	34.4	29.6	45.8
	Winter	52.4	5.5	44.9	.09	70.3	50.7	18.7	.15	19.6	32.0	31.1	45.8
Rusty blackhaw, *Viburnum rufidulum* Raf.	Spring	20.1	12.7	15.8	.35	27.2	21.9	6.0	.08	5.3	15.9	88.3	80.6
	Summer	56.7	3.1	46.0	.07	68.0	54.2	15.2	.06	13.8	39.0	32.8	53.8
	Autumn	56.6	4.4	40.0	.10	63.0	50.0	17.0	.09	13.0	33.0	42.2	52.9
	Winter	52.7	5.2	39.7	.12	63.6	48.3	16.7	.02	15.3	31.6	46.0	52.1

[1] Cell contents can be calculated as 100 minus CWC.

fiber or cell wall components (CWC), acid detergent fiber (ADF), and acid detergent lignin (ADL) by the procedures of Goering and Van Soest (1970). Crude protein, crude fat, crude fiber, calcium, and phosphorus were assayed by methods of the Association of Official Agricultural Chemists (1965).

Nylon-bag dry matter digestion (NBDMD) values were determined with ruminally cannulated goats (Short *et al.* 1974). Estimated true dry matter digestibility (ETDMD) was computed, by the equation described in Goering and Van Soest (1970), from CWC, the proportion of ADL in the ADF component, and the silica content.

Data on composition and digestibility were subjected to variance analyses (0.05 level of probability) to determine if seasonal differences occurred. In browse twigs the analysis for each nutrient took the form of a one-way classification contrasting the four seasons; the 20 species were viewed as replications. For leaves, the values obtained for each of the species during spring, summer, and autumn again served as replications, but two sample classes were recognized during winter. Thus, the format was that of a one-way analysis of variance with five levels. One winter sample class included the seven evergreen and tardily deciduous species or species groups: Japanese honeysuckle, blackberries, willow oak, common and saw greenbriers, water oak, yaupon, and loblolly and shortleaf pine. The second sample class included the other species, whose dry leaves were recovered from the ground. Duncan's multiple range test was used to further describe seasonal differences in nutrient quality. Correlation matrices were developed for both twigs and leaves.

Nutrient composition and digestibility of consecutive 1-inch twig segments were determined from common sassafras twigs collected in September. Values from three replicate collections of the terminal 6 inches were subjected to variance analyses and multiple range tests.

TWIG ANALYSES

Spring

At the time of the April collection shoot growth of all species was well established but was incomplete and succulent. In half the species, twig dry matter was less than 20 percent of green

tissue weight (table 1). The more succulent twigs tended to have lower fiber contents than average, but greater protein and phosphorus values. Protein contents varied from more than 30 percent in greenbriers to less than 10 in Alabama supplejack and pine twigs. Phosphorus varied from 0.17 percent in American and flatwoods plum to 0.71 in sassafras.

Cell contents representing the nonfibrous constituents of twigs ranged from 44 percent in willow oak to 81 in plum (values calculated as 100 minus CWC; see table 1). Half of the spring twigs had less than 40 percent CWC, less than 30 percent ADF, less than 20 percent cellulose and crude fiber, and less than 10 percent lignin. Pine, oaks, and Alabama supplejack had some of the highest fiber values.

Cell wall contents and other measures of fiber were significantly and negatively correlated with digestibility (table 2).

Spring twigs varied substantially in ETDMD —from 56 percent for pine to 86 percent for blackberry. Twigs with high digestibility had low CWC, ADF, and ADL content. Sufficient silica to appreciably reduce ETDMD was present only in American beautyberry.

NBDMD ranged from 52 percent for willow oak to 89 for plum. For 70 percent of the spring twigs the two digestibility estimates did not vary by more than 5 percentage points, and they varied by more than 10 percentage points only for greenbrier, sassafras, American beautyberry, and water oak.

Summer, Autumn, and Winter

Many woody twigs elongate rapidly during a brief portion of the growing season. Mean ending date of growth for Alabama supplejack and some grapes is in June. Sassafras, greenbriers, and rusty blackhaw end in July, and American beautyberry, common trumpetcreeper, and black tupelo end in August (Halls and Alcaniz 1972). As elongation ceases and twigs harden, dry matter and fiber content increase to levels which are maintained until regrowth begins the following year, while protein and digestibility diminish (Short *et al.* 1972). Mean composition and digestibility of twigs did not differ significantly in the summer, autumn, and winter samples, and therefore these data are lumped in table 2.

Crude protein in mature twigs did not exceed 8.3 percent for any of the species during summer, autumn, and winter (table 1), and some twigs had less than 4 percent. Phosphorus never exceeded 0.16 percent and dropped as low as 0.06 percent of dry matter. These values are clearly

Table 2.—*Correlation matrix for characteristics of browse twigs. Significant values (0.05 level) only are listed for immature twigs of 20 browse species collected during spring and for mature twigs collected during summer, autumn, and winter (N = 60)*

Characteristic	Season	ETDMD	Cellulose	Hemicellulose	NBDMD	Silica	ADL	ADF	CWC[1]	Phosphorus	Crude fiber	Protein
Dry matter	Spring	...	...	...	...	...	...	...	...	−0.62	0.56	−0.56
	Summer-autumn-winter	−0.50	...	0.32	−0.32	...	0.47	0.28	0.36	−.38	...	...
Protein	Spring	...	−0.56	...	...	...	...	−.45	...	.75	−.63	
	Summer-autumn-winter	...	−.40	...	...	0.33	...	...	...	.43	...	
Crude fiber	Spring	−.75	.90	...	−.75	...	.52	.86	.91	−.50		
	Summer-autumn-winter	−.64	.73	.48	−.84	...	.42	.87	.88	...		
CWC[1]	Spring	−.93	.88	...	−.83	...	.72	.94				
	Summer-autumn-winter	−.81	.66	.69	−.89	...	.54	.89				
ADF	Spring	−.91	.88	...	−.88	...	.82					
	Summer-autumn-winter	−.74	.75	.29	−.83	...	.59					
ADL	Spring	−.90	.45	...	−.82	...						
	Summer-autumn-winter	−.88	...	...	−.55	.26						
Silica	Summer-autumn-winter	−.33	...	...	...							
NBDMD	Spring	.83	−.69	...								
	Summer-autumn-winter	.76	−.57	−.56								
Hemicellulose	Summer-autumn-winter	−.54	...									
Cellulose	Spring	−.68										

[1] Correlation coefficients for cell contents are the same, except for sign, as those for cell wall contents.

less than the minimal standards for wildlife suggested by Halls (1970).

Only six samples of mature twigs—flowering dogwood at the three seasons, peppervine in summer, and sweetgum in summer and autumn—had cell content values greater than 50 percent of dry matter. These samples comprised most of the instances when NBDMD also exceeded 50 percent. In contrast, ETDMD was greater than 50 percent for 36 of the 60 samples of mature woody twigs. Discrepancies between NBDMD and ETDMD were major, averaging over 10 units (table 3). NBDMD of mature woody twigs was closely associated with cell content and could be predicted from the equation $\hat{Y} = 106.73—1.08$ CWC; r =—0.89 and the significant F value = 227.0. Clearly the very fibrous nature of mature woody twigs reduces their usefulness to herbivores.

The composition of a developing browse twig during spring usually did not bear a predictable relationship to the composition of the mature twig sampled at the other seasons. Except for protein, phosphorus, dry matter, and hemicellulose content during summer and autumn there were no significant relationships between the relative ranking of a nutrient in spring twigs and the relative nutrient content of twigs at other seasons. Mature twigs of a particular species, on the other hand, tended to have similarly high or low levels of nutrients during summer, autumn, and winter. Exceptions to this generalization are labile constituents such as phosphorus, which may be increased in twig tissues during winter because of translocation from leaves during autumn (Kramer and Kozlowski 1960). For mature woody twigs of a particular species, therefore, the measurements made during summer will still be a reasonable estimate of nutrient content during the subsequent autumn and winter.

Digestibility of Twig Segments

Quality and usefulness of mature twigs decrease with increasing distance from the meristematic bud tissues, more or less in proportion as dry matter and fiber increase. In sassafras twigs, crude protein, cell contents, phosphorus, and NBDMD of the 1-inch segment closest to the twig tip were significantly greater than in more distal segments (fig. 1). Few differences were noted after the fourth inch. ETDMD did not change after the second twig segment, apparently because ADL did not vary significantly between twig segments.

The difference in nutrient composition between twig segments may be related to the quantity of mature wood cell walls, the quantity of meristematic and bark tissues, and the lignin-carbohydrate associations in wood and bark. Composition of bark differs markedly from that of wood. For example, Short *et al.* (1972) de-

Table 3.—*Mean composition and estimated digestibility of twigs and leaves of 20 browse species*

Plant part and season	Dry matter	Crude protein	Crude fiber	Phosphorus	Cell contents	CWC	ADF	ADL	Silica	Hemicellulose	Cellulose	NBDMD	ETDMD
	Percent of green weight	*Percent of ovendry weight*											
TWIGS													
Spring	21.5[a1]	16.5[b]	21.0[a]	0.37[b]	64.2[b]	35.8[a]	28.1[a]	9.2[a]	0.22[a]	7.7[a]	18.9[a]	74.9[b]	73.1[b]
Summer	47.7[b]	4.7[a]	40.5[b]	.10[a]	38.9[a]	61.1[b]	50.5[b]	17.4[b]	.16[a]	10.5[a,b]	33.2[b]	40.1[a]	54.5[a]
Autumn	50.9[b]	5.5[a]	38.9[b]	.10[a]	37.8[a]	62.2[b]	48.5[b]	18.1[b]	.12[a]	13.7[b]	30.4[b]	40.1[a]	51.8[a]
Winter	54.1[b]	6.4[a]	39.8[b]	.10[a]	38.1[a]	61.9[b]	48.9[b]	19.8[b]	.53[a]	13.1[b]	29.1[b]	40.4[a]	49.3[a]
LEAVES													
Spring	28.2[a]	22.1[c]	13.2[a]	.42[b]	73.9[c]	26.1[a]	20.7[a]	9.0[a]	.37[a]	5.7[b]	11.7[a]	78.6[b]	77.1[b]
Summer	42.6[b]	10.3[b]	17.8[b]	.12[a]	65.0[b]	35.0[b]	26.6[b]	10.4[a]	.62[a]	8.4[b]	16.2[b]	67.4[b]	70.6[b]
Autumn	45.1[b]	10.1[b]	17.0[b]	.12[a]	68.1[b,c]	31.9[a,b]	24.8[a,b]	10.0[a]	.51[a]	7.4[b]	14.8[a,b]	68.0[b]	72.6[b]
Winter													
— Evergreen[2]	48.0[b]	11.3[b]	20.7[b]	.13[a]	64.6[b]	35.4[b]	25.8[a,b]	10.8[a]	.50[a]	9.6[b]	15.0[a,b]	65.0[b]	69.9[b]
— Deciduous[3, 4]		7.3[a]	20.3[b]	.08[a]	51.4[a]	48.6[c]	50.9[c]	27.5[b]	2.18[b]	2.3[a]	23.3[c]	44.9[a]	49.6[a]

[1] For twig or for leaf samples, the seasonal values within a column are significantly different if they bear different superscript letters.

[2] Values are for seven evergreen and tardily deciduous species.

[3] Values are for 13 deciduous species.

[4] As leaves of deciduous species were picked from the ground in winter, dry matter could not be measured reliably.

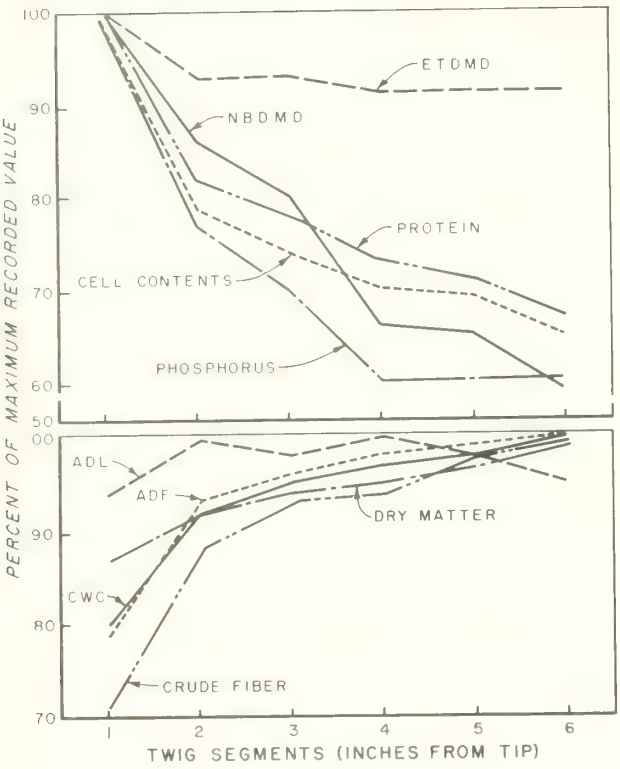

Figure 1.—*Nutritional composition and digestibility of 1-inch segments of sassafras twigs collected in September in east Texas.*

termined that bark of sassafras twigs contained more ash and benzene-alcohol and cold-water extractives (representing fats, fatty acids, resins and waxes, organic salts, simple sugars, cyclitols, gums, and pectin-like materials) than did wood. Also, lignin apparently limits digestibility less in bark than in wood, and digestible dry matter was three times greater in bark, although the two tissues were about equally digestible after delignification.

LEAF ANALYSES

Spring

Dry matter content of leaves (table 4) collected in spring was not significantly correlated with other leaf values (table 5). Crude protein averaged 22 percent in spring leaves and ranged from less than 11 percent for pine to greater than 30 percent for greenbriers, trumpetcreeper, and American beautyberry. Leaves with high protein contents also tended to have high phosphorus values ($r = 0.76$). Phosphorus averaged 0.42 percent and varied from more than 0.70 percent in trumpetcreeper and peppervine to 0.20 percent in Alabama supplejack. Cell contents exceeded 80 percent of dry matter for leaves of flowering dogwood, peppervine, blackberry, hawthorn, and plum, but amounted to only 46 percent in pine needles.

For all species combined, spring leaves averaged 13 percent crude fiber, 26 percent CWC, 21 percent ADF, 9 percent ADL, and 12 percent cellulose (table 3). The 2.9 percent silica content of American beautyberry leaves lowered ETDMD (spring twigs of this species also had high silica values).

ETDMD and NBDMD values were not so highly correlated ($r = 0.65$) for spring leaves as for spring twigs ($r = 0.83$, table 2). Perhaps the reduced correlation is due to the presence of waxes, oils, resins, or other leaf components that affect either NBDMD values or reliability of the detergent fiber analyses, or both.

Summer and Autumn

Leaves of few species had as much as 13 percent protein or 0.20 percent phosphorus during summer and autumn. Still, cell contents and NBDMD averaged more than 65 percent during these seasons (table 3). Dry matter and crude fiber were significantly higher, and protein and phosphorus lower, during summer and autumn than during spring. ADL, hemicellulose, silica, and leaf digestibility changed little from spring through summer.

Winter

Leaves of the evergreen and tardily deciduous species—Japanese honeysuckle, blackberry, willow oak, greenbriers, water oak, yaupon, and pine—were lumped for the analysis (table 3), since their nutrient contents did not vary much from summer to winter.

The other species are deciduous. Leaves were collected from the ground during winter, and no dry matter determinations were made. Protein, cell contents, NBDMD, and ETDMD of these weathered leaves usually were sharply diminished from summer-autumn values, and most fiber contents were sharply increased. Translocation from the leaf before fall and leaching of nutrients afterwards probably account for the differences. Detergent analyses of weathered leaves collected during winter were imprecise as ADF measures of these tissues frequently exceeded CWC levels.

Table 4.—*Composition and digestibility of leaves from 20 browse species collected in east Texas at the four seasons*

Species	Season collected	Dry matter	Crude protein	Crude fiber	Phosphorus	CWC[1]	ADF	ADL	Silica	Hemicellulose	Cellulose	Digestibility	
												NBDMD	ETDMD
		Percent of green weight	*Percent of ovendry weight*										
Loblolly and shortleaf pine	Spring	34.7	10.8	33.3	0.22	53.8	39.1	14.7	0.19	14.7	24.4	44.8	57.7
	Summer	36.5	7.9	35.1	.11	49.8	43.9	16.5	.98	5.9	27.4	38.9	60.7
	Autumn	39.7	9.1	30.3	.13	45.1	37.0	15.4	.59	8.1	21.6	49.0	62.6
	Winter	41.4	9.9	27.4	.13	40.6	33.8	15.0	.69	6.8	18.8	49.8	65.3
Common and saw greenbriers	Spring	17.6	30.9	9.7	.63	22.8	13.6	5.8	.30	9.2	7.8	91.2	79.9
	Summer	35.2	11.7	27.6	.11	43.9	34.1	12.3	.08	9.8	21.8	65.7	65.7
	Autumn	41.0	11.1	25.2	.11	40.6	30.3	10.2	.21	10.3	20.1	66.5	69.1
	Winter	42.3	12.3	23.3	.13	38.5	26.8	8.8	.05	11.7	18.0	74.3	70.9
Willow oak	Spring	30.0	18.5	18.3	.48	38.4	24.3	11.7	.22	14.1	12.6	43.4	66.0
	Summer	50.2	11.1	25.2	.11	44.9	32.1	14.0	.25	12.8	18.1	37.3	62.1
	Autumn	54.7	12.1	22.0	.12	43.3	31.7	14.7	.29	11.6	17.0	41.5	62.4
	Winter	56.9	10.3	23.2	.13	41.5	29.9	12.7	.10	11.6	17.2	48.4	65.1
Water oak	Spring	29.9	19.1	16.7	.32	34.6	20.1	8.3	.09	14.5	11.8	59.0	70.9
	Summer	52.3	10.3	25.9	.09	49.0	35.4	14.2	.31	13.6	21.2	41.2	60.2
	Autumn	57.5	12.2	27.1	.12	46.2	32.8	14.1	.28	13.4	18.7	40.3	61.2
	Winter	57.4	10.5	24.6	.11	42.5	30.6	13.1	.43	11.9	17.5	50.9	64.2
Winged elm	Spring	34.5	27.6	11.5	.46	21.7	16.1	5.8	.34	5.6	10.3	89.7	82.9
	Summer	55.2	11.2	20.6	.12	37.9	31.3	12.3	5.17	6.6	19.0	54.4	53.5
	Autumn	55.0	8.8	20.7	.12	38.0	31.9	11.6	1.30	6.1	20.3	51.4	66.0
	Winer	(2)	7.3	25.8	.07	61.4	55.9	30.8	2.54	5.5	25.1	26.6	36.3
Common sassafras	Spring	23.9	28.3	16.4	.46	29.6	23.1	9.3	.27	6.5	13.8	79.2	75.1
	Summer	36.0	12.3	18.2	.14	45.3	29.5	13.1	.18	15.8	16.4	69.4	61.5
	Autumn	37.3	9.6	15.3	.10	36.0	22.8	10.0	.03	13.2	12.8	77.4	69.1
	Winter	(2)	5.5	27.5	.07	65.2	58.7	37.5	.04	6.5	21.2	22.7	37.3
American sweetgum	Spring	25.8	16.9	9.4	.30	21.1	18.3	7.0	.47	2.8	11.3	71.5	82.1
	Summer	35.6	9.8	11.2	.11	35.9	30.9	10.7	1.03	5.0	20.2	54.2	69.0
	Autumn	37.9	9.9	9.4	.13	20.4	21.7	7.9	2.27	0.0	13.8	61.7	76.1
	Winter	(2)	5.3	17.3	.06	40.5	65.2	36.6	6.12	0.0	28.6	39.1	43.7
Hawthorns	Spring	35.8	19.0	9.8	.34	18.9	17.3	8.6	.11	1.6	8.7	90.0	82.0
	Summer	58.1	7.6	14.2	.09	26.7	21.0	9.8	.27	5.7	11.2	72.8	76.0
	Autumn	67.7	7.1	12.9	.08	29.5	26.0	13.4	.23	3.5	12.6	53.1	72.7
	Winter	(2)	7.4	18.3	.07	45.9	49.4	31.8	1.18	0.0	17.6	34.4	51.6
American and flatwoods plum	Spring	34.8	26.2	6.5	.57	12.2	10.3	4.3	.25	1.9	6.0	91.8	88.4
	Summer	50.7	11.1	12.2	.12	23.2	18.3	10.2	.29	4.9	8.1	85.0	77.5
	Autumn	53.0	13.1	9.6	.14	17.0	12.4	6.2	.09	4.6	6.2	89.4	83.6
	Winter	(2)	9.0	13.8	.08	40.2	41.0	26.4	4.02	0.0	14.6	58.8	48.4
Blackberry	Spring	32.6	24.3	13.0	.44	19.9	16.8	4.2	.22	3.1	12.6	82.2	85.9
	Summer	41.0	10.0	15.6	.12	31.1	22.7	7.7	.25	8.4	15.0	58.9	75.8
	Autumn	45.4	13.4	14.2	.15	28.0	19.8	6.9	.14	8.2	12.9	62.9	77.7
	Winter	52.3	11.7	14.9	.14	27.7	18.5	5.6	.26	9.2	12.9	70.3	79.3
Yaupon	Spring	31.2	18.4	12.5	.26	35.1	43.1	29.6	.08	0.0	13.5	80.9	64.4
	Summer	47.9	11.3	22.0	.08	40.0	31.6	15.0	.09	8.4	16.6	74.2	64.8
	Autumn	47.1	12.2	20.8	.12	35.2	26.9	12.7	.63	8.3	14.2	76.2	68.9
	Winter	50.5	11.6	17.7	.10	30.9	23.3	10.5	1.12	7.6	12.8	77.4	69.6
Alabama supplejack	Spring	33.5	16.2	8.9	.20	20.7	14.1	5.3	.13	6.6	8.8	92.6	82.5
	Summer	46.5	9.3	12.0	.07	30.5	18.6	6.6	.33	11.9	12.0	85.0	75.7
	Autumn	47.5	8.6	12.3	.08	23.5	17.9	8.3	.08	5.6	9.6	85.2	78.7
	Winter	(2)	8.3	17.4	.07	51.2	53.9	36.3	2.31	0.0	17.6	41.1	42.5
Peppervine	Spring	27.2	25.3	9.0	.72	14.0	13.1	5.7	.41	0.9	7.4	70.1	86.8
	Summer	38.6	13.8	8.7	.18	17.3	16.8	6.4	.32	0.5	10.4	65.0	85.0
	Autumn	43.2	13.5	9.7	.21	17.9	21.0	7.3	.16	0.0	13.7	78.3	85.1
	Winter	(2)	6.6	15.8	.13	42.5	65.1	40.6	2.28	0.0	24.5	29.7	51.9
Grapes	Spring	21.0	24.2	22.4	.60	37.9	33.6	12.3	.40	4.3	21.3	75.4	69.9
	Summer	33.3	12.1	13.3	.15	32.5	21.8	6.7	.86	10.7	15.1	86.5	75.9
	Autumn	39.2	8.0	13.5	.14	28.4	24.7	8.3	1.85	3.7	16.4	81.1	72.2
	Winter	(2)	6.9	23.8	.07	51.0	51.6	27.6	.11	0.0	24.0	49.0	53.6

Table 4.—*Composition and digestibility of leaves from 20 browse species collected in east Texas at the four seasons* (Continued)

Species	Season collected	Dry matter	Crude protein	Crude fiber	Phosphorus	CWC[1]	ADF	ADL	Silica	Hemicellulose	Cellulose	Digestibility	
												NBDMD	ETDMD
		Percent of green weight	*Percent of ovendry weight*										
Flowering dogwood	Spring	31.7	20.7	13.8	.26	19.7	17.5	7.3	.12	2.2	10.2	82.8	82.5
	Summer	39.7	8.3	13.9	.09	20.6	20.0	4.8	.22	0.6	15.2	79.4	85.7
	Autumn	43.5	7.4	11.5	.08	19.4	18.2	5.0	.14	1.2	13.2	79.5	85.5
	Winter	([2])	5.9	17.8	.06	30.4	32.6	9.7	.09	0.0	22.9	85.5	77.6
Black tupelo	Spring	20.3	15.1	10.8	.22	27.2	17.8	6.4	.10	9.4	11.4	80.9	78.0
	Summer	39.4	8.8	14.8	.10	34.8	19.0	6.5	.14	15.8	12.5	54.7	73.0
	Autumn	41.4	6.8	17.9	.07	40.3	20.4	7.6	.06	19.9	12.8	56.7	67.9
	Winter	([2])	6.4	22.8	.11	43.5	35.5	16.4	1.85	8.0	19.1	56.7	56.8
American beautyberry	Spring	22.4	33.5	11.4	.46	28.5	21.3	8.3	2.89	7.2	13.0	84.4	67.6
	Summer	30.9	13.7	18.5	.19	41.0	33.4	10.6	.23	7.6	22.8	76.4	69.6
	Autumn	31.8	10.1	18.2	.15	34.2	27.1	9.0	.51	7.1	18.1	80.7	73.8
	Winter	([2])	9.0	22.3	.08	55.1	49.6	18.2	3.75	5.5	31.4	46.7	45.9
Common trumpetcreeper	Spring	22.3	30.2	10.2	.71	24.5	20.3	8.8	.33	4.2	11.5	84.6	78.4
	Summer	44.0	9.6	19.2	.12	36.9	25.6	9.3	.38	11.3	16.3	79.1	70.8
	Autumn	42.0	6.9	21.6	.10	38.5	28.0	10.1	.47	10.5	17.9	73.9	69.7
	Winter	([2])	11.3	20.6	.14	56.0	51.9	23.1	2.74	4.1	28.8	30.4	44.6
Japanese honeysuckle	Spring	28.0	16.2	10.9	.39	20.7	15.9	7.3	.19	4.8	8.6	86.5	81.1
	Summer	38.0	9.0	13.5	.20	30.2	24.3	15.6	.57	5.9	8.7	84.3	69.8
	Autumn	32.7	13.4	14.7	.18	28.6	20.2	12.0	.46	8.4	8.2	84.7	72.1
	Winter	35.5	12.6	13.9	.18	26.0	17.8	9.8	.86	8.2	8.0	84.9	75.1
Rusty blackhaw	Spring	26.8	20.7	9.6	.38	21.1	18.0	8.9	.19	3.1	9.1	91.2	80.2
	Summer	43.0	7.0	13.9	.08	27.8	22.1	6.1	.38	5.7	16.0	84.7	80.1
	Autumn	43.7	7.7	13.4	.09	28.6	24.8	8.2	.40	3.8	16.6	80.3	77.8
	Winter	([2])	6.2	20.8	.07	48.6	49.7	22.8	1.29	0.0	26.9	67.6	54.4

[1] Cell contents can be calculated as 100 minus CWC.
[2] No dry matter measurements were made on winter leaves picked from the ground.

Leaves of a species with relatively high or low levels of a nutrient during spring tended to have proportionally high or low levels of that nutrient during summer and autumn (table 4). Summer values were related to those observed in autumn and, for evergreen and tardily deciduous species, to winter values also. Nutrient levels in fallen leaves bore no significant resemblance to those in living leaf tissues.

DISCUSSION

During spring, rapidly growing twigs are a quality forage and are digested by ruminants about as efficiently as are quality herbages (Short *et al.* 1974). Dry matter and fiber content are low, and protein, phosphorus, cell content, and digestibility are higher than at any other season. ETDMD of succulent twigs (table 3) suggests that most of the cell contents and about 25 percent of the CWC are digested.

Twigs are generally mature by summer, at which time their protein, cell content, and digestibility values are less than in spring, and fiber and dry matter contents are greater. NBDMD of mature browse twigs about equaled cell contents; these values were less than the ETDMD estimates. Presumably, the equation for ETDMD does not adequately weigh the efficiency with which lignins in cell walls of mature wood reduce digestibility (Short *et al.* 1973). CWC, the largest plant fraction in mature woody twigs, essentially is metabolically unavailable to small ruminants like deer (Short and Reagor 1970). Mature woody twigs thus are of less value than would be suggested by a simple comparison of their composition with that of other foodstuffs like herbages.

Because major and rapid changes in nutrient content occur throughout the brief period of rapid twig growth, it is necessary to sample twigs frequently during springtime (Short 1967). By summer, elongation has ceased and twigs have matured so that sampling intensity can be reduced.

Browse leaves had more protein, phosphorus, and cell contents in spring than at other seasons.

Table 5.—*Correlation matrix for leaf components and digestion indices for browse leaves collected in spring, summer-autumn, and winter from east Texas. Only significant values are listed*

Characteristic	Season and plant type[1]	ETDMD	Cellulose	Hemicellulose	NBDMD	Silica	ADL	ADF	CWC[2]	Phosphorus
Dry matter	Summer-autumn	...	...	...	...	...	...	...	...	−0.40
Protein	Spring	...	...	...	...	0.52	...	...	...	.76
	Summer-autumn	...	...	...	...	...	...	...	...	.66
	Winter									
	Evergreen	0.77	...	...	0.95	...	−0.77	−0.83	...	...
Crude Fiber	Spring	−.77	0.92	0.58	−.74	...	...	.72	0.90	...
	Summer-autumn	−.71	.79	.40	−.52	...	.64	.85	.83	...
	Winter									
	Evergreen	−.86	.94	...	−.81	...	.76	.99	.96	...
	Deciduous	...	...	.72	...	...	...	...	.76	...
CWC[2]	Spring	−.95	.88	.67	−.73	...	.60	.84		
	Summer-autumn	−.91	.74	.71	−.63	...	.73	.86		
	Winter									
	Evergreen	−.89	.92	...	−.86	...	...	.95		
	Deciduous	−.79	...	.58	−.69	...	...	...		
ADF	Spring	−.86	.82	...	−.49	...	.89			
	Summer-autumn	−.82	.90	...	−.66	...	.80			
	Winter									
	Evergreen	−.92	.90	...	−.86	...	.84			
	Deciduous	−.68	...	...	−.76	...	.86			
ADL	Spring	−.71	.47	...	...	...				
	Summer-autumn	−.82	.45	...	−.55	...				
	Winter									
	Evergreen	−.92	...	...	...	...				
	Deciduous	−.67	...	...	−.79	...				
Silica	Summer-autumn	−.36	...	...	...					
	Winter									
	Evergreen	...	...	−.79	...					
NBDMD	Spring	.65	−.59	−.65						
	Summer-autumn	.64	−.57	...						
	Winter									
	Evergreen	.76	−.80	...						
	Deciduous	.85	...	...						
Hemicellulose	Spring	−.59	...	...						
	Summer-autumn	−.58								
Cellulose	Spring	−.78								
	Summer-autumn	−.61								

[1] Winter values were determined for leaves of 7 evergreen and tardily deciduous species and 13 deciduous species.
[2] Correlation coefficients for cell contents are the same, except for sign, as those for cell wall contents.

Their dry matter and crude fiber contents increased during summer-autumn, at which times phosphorus and protein declined. Nutrient quality and digestibility of fallen and weathered leaves were much diminished, but leaves of evergreen and tardily deciduous species changed little during winter. Whereas growing and maturing leaves should be frequently sampled to describe their changing nutrient content, a single collection of mature leaves might be adequate during summer-autumn and for nondeciduous leaves also during winter.

As living leaves of browse plants characteristically have a high ADL:ADF proportion (Short *et al.* 1974), their limited CWC fraction may be of little utility to herbivores. Still, the digestibility is high because cell contents are abundant.

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1975. Composition and digestibility of deer browse in southern forests. South. For. Exp. Stn., New Orleans, La. 10 p. (USDA For. Serv. Res. Pap. SO-111)

Twigs were most nutritious and digestible during early growth in spring; they were high in fiber content and low in digestibility during summer, autumn, and winter. Evergreen leaves did not vary substantially in nutrient content and digestibility throughout the year. By contrast, leaves of deciduous species were reduced in quality and digestibility after leaf-fall.

Additional keywords: Forage quality, wildlife foods, woody twigs, nutrients, ruminants, *in vivo* microdigestion.

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Seedbed Preparation Aids Natural Regeneration Of Longleaf Pine

Thomas C. Croker, Jr.

Southern Forest Experiment Station
Forest Service
U.S. Department of Agriculture
1975

Seedbed Preparation Aids Natural Regeneration Of Longleaf Pine

Thomas C. Croker, Jr.[1]

In south Alabama, establishment, survival, and growth of longleaf pine were improved by winter or fall burning before seedfall. Mechanical seedbed preparation was helpful after a fire and imperative when no burn was made.

Additional keywords: *Pinus palustris* Mill., shelterwood, direct seeding, supplemental seeding.

Deficient seed supply is a problem in the natural regeneration of longleaf pine (*Pinus palustris* Mill.). The species is less fruitful than other major southern pines, and bumper crops may be some years apart. Marginal crops occur more frequently, and then the forester has a choice of at least two measures. He may try to increase tree percent (number of established seedlings per 100 seeds) by careful preparation of the seedbed. He may also reinforce the natural crop by distributing seed that has been treated with materials repellent to predators.

This paper reports a 7-year study to appraise various types of bed preparation and test the utility of supplemental seeding.

METHODS

Layout.—The study was on two sharply contrasting sites of the Escambia Experimental Forest in south Alabama. One site, hereafter called good, was a Bowie soil characterized by a fine sandy loam A horizon grading to a sandy clay B horizon at about 26 inches. Understory vegetation was mainly gallberry, *Ilex glabra* (L.) Gray, less than 4 feet high. Larger brush and hardwoods had been controlled with chemicals or fire 2 or more years previously. The second, and poorer, site was an Alaga soil with nothing heavier than a loamy sand within 4 feet of the surface. Understory vegetation was principally grass dominated by little bluestem (*Andropogon scoparius* Michx.). Topogra-

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phy was level at both locations. The overstory was pure longleaf pine about 60 years old, ranging in density from 30 to 60 square feet of basal area per acre.

Five annual replications began with the 1966 and concluded with the 1970 seed year. Three blocks were established annually on each of the two sites. Each block consisted of three 66-foot-square plots. Plots were subdivided into six minor plots.

Burning treatments.—A winter burn, a fall burn, and no burn (check) were randomly assigned among the three plots in each block. Winter burns were made in February, about 9 months ahead of seedfall, on days when air temperatures ranged from 56° to 79° F, relative humidity from 40 to 60 percent, and ground winds from 5 to 10 miles per hour. Fall burns were made between September 15 and October 9, just before seedfall; temperatures ranged from 78° to 90°F, relative humidity from 45 to 60 percent, and ground winds from 2 to 8 miles per hour.

Seedbed treatments.—Six seedbed treatments were superimposed on each burning plot. They included four mechanical treatments, one chemical treatment, and a check or no treatment. Mechanical treatments were:

Disked with a 6-foot tandem farm disk.

Rototilled with a 5-foot machine set to cut 3 to 5 inches deep.

Rototilled and then worked with a 3-foot cultipacker.

Scaribedded with a specially designed implement that includes a scalper followed by a chopper. The scalper is set shallow to clear away debris but leave most of the topsoil in place. The chopper loosens the soil and makes shallow dams perpendicular to the line of travel. Beds are about 3 feet wide.

Mechanical treatments were applied in February on unburned plots and immediately after the fire on burned plots.

The chemical treatment was a soil sterilant (Dalapon[2]) applied in June of each year with a backpack sprayer. Application was at the rate of 20 pounds per acre.

Supplemental seeding.—Seedfall was monitored with five ¼-milacre traps on each major plot. The crop of 1967 provided 137,000 seeds per acre on the good site and 41,000 on the poor site. Counts in other years were: none in 1966 and 1970, 2,000 per acre in 1968, and 2,000 to 7,000 in 1969. To supplement these amounts, seed coated with repellents was distributed in quantities sufficient to provide the equivalent of 100,000 natural seeds per acre. It was considerd that one re

[2] Mention of trade names is for information only, and does not constitute an endorsement by the U. S. Department of Agriculture.

Mann, W. F., Jr. 1970. **Direct-seeding longleaf pine.** USDA For. Serv. Res. Pap. SO-57, 26 p. South. For. Exp. Stn., New Orleans, La.

pellent-treated seed would be as effective as five natural ones. Thus, 20,000 treated seeds per acre were sown in every year except 1967, when the only supplementation was 12,000 treated seeds per acre on the poor site.

Laboratory germination of treated seeds averaged 76 percent; it ranged from 57 percent in 1969 to 87 percent in 1968.

Examinations and analyses.—In all five yearly replications, an examination was made during March of the year following seedfall and then annually each November through 1973. In the March examination, tree percents were determined for three classes of seed: protected, treated, and natural. Data on protected seed were obtained from three treated seeds sown under each of sixteen ¼-inch wire mesh cones per subplot. Information on treated seed was derived annually from the repellent-coated supplementary sowings, which were not protected by screens. Data on natural seed were from the 1967 crop on good sites, as this was the only instance in which treated seeds were not applied.

Survival percentages are based on the number of seedlings (from treated plus natural seed) that survived from the March counts to the November counts. Growth is in terms of the root collar diameter of the largest seedlings on each of eight ¼-milacre quadrats per subplot in November. Survival and growth through age 6 years were determined only for trees originating from the 1966 and 1967 seedings, as the study was terminated before younger pines reached that age.

Effects of treatment on seedling establishment in each year, and survival and growth through age 6 for seedlings established in 1966 and 1967, were tested by analysis of variance at the 0.05 level of significance. Establishment and survival percents were transformed (arcsin $\sqrt{\text{proportion}}$) before analysis.

RESULTS

Establishment

Effects of site and seedbed treatments on establishment tree percents are shown in table 1.

Both burning and mechanical site preparation significantly improved establishment. The chemical treatment was ineffective. The best mechanical treatment was rototilling plus cultipacking, although differences were minor if treatments were preceded by a burn. The one pass with a light farm disk was not very useful without a burn. The winter burn was somewhat more effective than the fall burn but only with unprotected seeds, especially natural seeds. As often happens, seed predators appeared to be more of a problem on fresh burns than in a 1-year rough.

Table 1.—*Longleaf pine seedling establishment in relation to site, seedbed treatments, and seed origin*

Treatment	Treated seeds				Unprotected natural seed, good site[3]	Weighted annual average all seeds and sites
	Protected[1]		Unprotected[2]			
	Good site	Poor site	Good site	Poor site		
	Tree percent[4]					
No burn						
Disk	28	27	14	15	29	22
Rototill	48	38	21	28	26	34
Roto-cultipack	49	42	28	34	39	39
Scaribed	41	34	22	20	35	30
Chemical	18	21	11	9	16	15
None	23	22	11	12	18	18
Mean	34	31	18	20	27	26
Winter burn						
Disk	51	45	33	30	51	41
Rototill	54	45	31	38	35	42
Roto-cultipack	52	49	33	45	31	45
Scaribed	46	42	22	31	57	37
Chemical	42	37	22	24	41	33
None	46	40	26	28	54	37
Mean	48	43	28	33	45	39
Fall burn						
Disk	50	42	22	21	45	36
Rototill	56	46	27	28	44	41
Roto-cultipack	51	44	33	32	47	41
Scaribed	48	39	20	23	26	33
Chemical	47	36	18	22	21	31
None	45	37	18	25	28	32
Mean	50	41	23	25	35	36
All	44	38	23	26	36	34

[1] All 5 years.

[2] All years but 1967.

[3] 1967 only.

[4] Number of established seedlings in March per 100 seeds dispersed.

The following tabulation illustrates the effectiveness of burning or of the best mechanical treatment in improving tree percents of treated seeds:

	Good site	Poor site
No treatment	17	17
Burn alone	34	32
Mechanical alone	38	38
Burn plus mechanical	44	43

Burning nearly doubled and mechanical treatment more than doubled seedling establishment. Burning followed by the mechanical treatment was more effective than either treatment alone. Site quality apparently had no effect.

Survival and Growth

Survival of seedlings established in 1966 and 1967 was recorded at age 6 (table 2). It was significantly improved by burning and by some types of mechanical treatments on both good and poor sites. Burning greatly improved survival regardless of added treatments. Mechanical treatment was particularly helpful in the absence of a burn but did not consistently improve survival over that achieved with burning alone. Survival was better on good sites than on poor ones.

The relationship of site and seedbed treatments to seedling size at age 6 was based on the root collar diameter of the largest seedling on each ¼-milacre quadrat (table 3). Growth was significantly improved by pre-seedfall burning, but not by mechanical or chemical treatments. Growth did seem to improve after some of the mechanical treatments on unburned sites, however.

APPROXIMATIONS OF SEED REQUIREMENTS

Past observations have indicated that about 20 percent of a natural seedling stand will consist of brown-spot resistant individuals capable of rapid early growth. If the manager's objective is 500 of these superior crop seedlings per acre at age 6, a population of 2,500 seedlings will be necessary at that time. The number of seeds needed to achieve this goal depends on establishment and survival, both of which are affected by seedbed treatments. In table 4, necessary amounts of natural seed have been established for all bed conditions studied. The estimates are based on the tree percents for repellent-coated, protected seeds over 5 years of observation, as they most closely reflected the effect of bed treatments. Predators make large inroads. To allow for them the observed tree percent of 44 for protected seed on the good site was reduced to 20 percent. This value seemed reasonable, as it is close to the 8-year average obtained in regional trials of the shelterwood system of regenerating longleaf pine. Proportionate adjustments were then made in other observed tree percents by multiplying each value by $\frac{20}{44}$ or 0.4545. These values and the sixth-year survival percentages (table 2) provided estimates of the number of seeds needed in each treatment combination to provide 2,500 seedlings at age 6. The formula was:

$$\text{Seeds needed} = \left(\frac{100}{\text{adjusted tree }\%}\right)\left(\frac{100}{\text{survival }\%}\right)(2{,}500)$$

Table 2.—*Survival of established seedlings through age 6*

Treatment	Good site	Poor site
	Percent	
No burn		
Disk	4	1
Rototill	5	5
Roto-cultipack	21	13
Scaribed	21	7
Chemical	6	4
None	6	1
Mean	10	5
Winter burn		
Disk	27	14
Rototill	28	13
Roto-cultipack	19	14
Scaribed	31	30
Chemical	31	24
None	19	15
Mean	26	18
Fall burn		
Disk	28	17
Rototill	27	24
Roto-cultipack	33	14
Scaribed	38	25
Chemical	21	21
None	24	21
Mean	28	20

Table 3.—*Root-collar diameter of largest seedling per 1/4-milacre at age 6*

Treatment	Good site	Poor site
	— Inch —	
No burn		
Disk	0.34	0.18
Rototill	.33	.39
Roto-cultipack	.52	.52
Scaribed	.56	.39
Chemical	.28	.29
None	.31	.13
Mean	.39	.32
Winter burn		
Disk	.63	.60
Rototill	.61	.52
Roto-cultipack	.52	.60
Scaribed	.51	.73
Chemical	.54	.61
None	.58	.49
Mean	.56	.59
Fall burn		
Disk	.56	.65
Rototill	.57	.53
Roto-cultipack	.54	.52
Scaribed	.55	.57
Chemical	.49	.57
None	.54	.61
Mean	.54	.58

One word of caution: table 4 is intended only as a rough approximation. Seed requirements vary with local conditions. If they will keep records of their local experience, land managers will have a better guide than is offered by the table.

CONCLUSIONS

It is clear that longleaf pine seedling establishment, survival, and growth through age 6 years can be greatly improved by a fire in advance of seedfall. If no burning is done, mechanical site treatment is imperative.

While burning is the most practical measure, an additional treatment with an implement such as a scaribedder—with or without supplemental seeding—may improve chances for regeneration. Mechanical treatments may be particularly useful where brush competition is severe; in this study their effect was to improve survival rather than to increase tree percent.

able 4.—*Estimated*[1] *natural seed requirements to provide 500 superior crop seedlings per acre at age 6*

Treatment	Good site	Poor site
	M seeds per acre	
o burn		
Disk	488	2,050
Rototill	230	290
Roto-cultipack	53	102
Scaribed	64	233
Chemical	509	650
None	400	2,500
inter burn		
Disk	40	87
Rototill	37	94
Roto-cultipack	55	80
Scaribed	38	43
Chemical	42	62
None	63	92
ıll burn		
Disk	40	78
Rototill	36	50
Roto-cultipack	32	89
Scaribed	30	56
Chemical	56	72
None	51	71

[1] stablished seedlings per acre needed = 100/survival percent) (2,500). Seeds per acre eeded = (100/tree percent) (established eedlings/acre needed).

When preceded by a burn and effective mechanical site preparation, supplemental seeding at a rate of 20,000 repellent-coated seeds per acre established adequate stands during each of the poor seed years.

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

Croker, Thomas C., Jr.

1975. Seedbed preparation aids natural regeneration of longleaf pine. South. For. Exp. Stn., New Orleans, La. 7 p. (USDA For. Serv. Res. Pap. SO–112)

In south Alabama, establishment, survival, and growth of longleaf pine were improved by winter or fall burning before seedfall. Mechanical seedbed preparation was helpful after a fire and imperative when no burn was made.

Additional keywords: *Pinus palustris* Mill., shelterwood, direct seeding, supplemental seeding.

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Tree Farm Families In the South

Alfred Pleasonton

Southern Forest Experiment Station
Forest Service
U.S. Department of Agriculture

1975

Pleasonton, Alfred

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The tree farm family, a group of private forest landowners associated informally with a forest products company, is regarded as a success by nearly every company interviewed. Landowners get forest management help, and companies get first refusal rights to the timber. Family characteristics differ from firm to firm, and agreements can be oral or written.

Additional keywords: Wood procurement, forest management, refusal rights.

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A tree farm family is a group of private forest landowners associated in a unique and informal way with a forest products company. The landowners get help in managing their forest acreage, and the company gets preference in buying timber from them.

A study was conducted by personal interview in 1973 to learn the important characteristics of several companies' tree farm families in the South. Perhaps as many as 30 families exist throughout the region; 11 were interviewed.

These 11 families can be divided into two categories: those that wish to expand and those that do not. The seven expanding families average 67 landowners each, and each family has an aggregate acreage of 50,722 (table 1). The four nongrowing families average 20 landowners each, and each family has a total of 55,520 acres (table 2). Expanding families typically include a high number of owners with 50 to 1,000 acres each and few with over 2,500 acres. Although the nongrowing families have few owners in any acreage class, an average of two owners in each of the top two classes accounts for more than three-fourths of these families' total acreage.

Apparently the age of a tree farm family is closely correlated to the company's desire for expansion. All the nongrowing families were established by the late 1950's; most expanding families were created in the 1960's. The average of the establishment dates is 1944 for the first group and 1960 for the second.

Table 1.—*Dimensions of the average expanding tree farm family*

Acreage class	Number of ownerships	Total ownership size
		Acres
Less than 50	3	123
50–249	21	3,507
250–999	31	16,089
1,000–2,499	9	13,041
2,500–4,999	2	6,712
5,000 and over	1	11,250
Totals	67	50,722

Table 2.—*Dimensions of the average nongrowing tree farm family*

Acreage class	Number of ownerships	Total ownership size
		Acres
Less than 50	1	20
50–249	5	780
250–999	5	1,885
1,000–2,499	5	9,335
2,500–4,999	2	7,500
5,000 and over	2	36,000
Totals	20	55,520

Company attitudes toward expansion have shifted somewhat in recent years. In 1970 two of the corporations stated they wanted to expand their small families,[1] but by 1973 their families had shrunk. In contrast, a firm uninterested in expansion of its large family in 1970 had both expanded its family and changed its attitude by 1973. Generally, enthusiasm for family expansion has slackened slightly. Probably part of the change is due to difficulty in finding good new prospects. Also, some members succeeded in getting higher bids for their timber than the parent company was willing to match. Part, no doubt, is also due to general austerity in company attitudes induced by a receding economy. Some companies were already employing fewer foresters. New owners added to the families in 1973 tended to be people who sought the company, rather than vice versa.

Criteria for Membership

The minimum acceptable acreage for membership in tree farm families ranges from 500 acres downward; half the companies reported

[1] Siegel, William C. 1973. **Long-term contracts for forest land and timber in the South.** U. S. Dep. Agric. For. Serv., Res. Pap. SO-87, 14 p. South. For. Exp. Stn., New Orleans, La.

o lower limit. Almost twice as many nongrowing families as expanding amilies specified lower limits, however.

When firms were asked what other criteria they have for family iembership, the majority reported only one or two requirements. The iost common criterion—even more frequent than a minimum acreage—is landowner interest in producing timber on a long-term basis. and speculators are barred from family membership. Two criteria pecified by some firms are existence of standing timber and a willingess indicated by the landowner to invest money in planting or improvig stands. Other criteria less frequently mentioned include the landwner's integrity, willingness to follow company recommendations, nd recognition as a community leader.

A related question pursued the landowner characteristics that irms considered most important. Overwhelmingly, the responses were iterest in timber production and affluence or moderate affluence. ower in frequency was status as an absentee, implying someone not onstantly around and possibly complicating the job of timber manageient. An average of 25 percent of the members of expanding tree arm families live more than 50 miles from their forests; the percentge of absentee owners ranges from 0 to 53 percent. The percentage f absentees in nongrowing families ranges from 0 to 100 percent and verages 54 percent. The overall average for all families is 36 percent.

Services to Members

As a member of a tree farm family, the landowner receives help n managing his forest. The three services all companies offer free are nanagement planning, timber marking, and marketing of those forest roducts the company does not wish to buy. A fourth free service offered by practically all companies is a timber inventory. This inventory is useful to both the company and the owner for developing he management plan and deciding what trees might profitably be emoved from the forest to increase future productivity of the land or to prepare for type conversion or interplanting in understocked tands.

All firms offer planting at cost, often including special preparatory work, if needed; and practically all offer stand improvement. Either of these services may be done by company crews or contract crews the company forester obtains. Crews typically are paid by the landowner, but the company forester provides supervision.

Boundary surveys, when needed, are normally arranged by contract between the owner and a registered surveyor. Sometimes the company forester may be able to save the owner this expense if he can have a crew retrace the established property lines.

These seven services are the only ones that are generally availabl to tree farm family members. Several other services are offered b fewer than half the companies, some fully paid for by the compan and some largely at cost to the landowner.

About a third of the companies offer fire suppression free, es pecially if the family member's land is near company land. Almos half will plow fire lanes at cost around or through an owner's fores or will supervise the work done by a contractor. One company wi plow these lanes free.

A few companies provide free some degree of surveillance fo insect or disease infestations or for timber theft. Least commonly of fered are these last four services: game management work (25 t 40 percent subsidized by the company), roadwork (a little provide free and some at cost to the landowner), free appraisal of oil fiel damage, and a free newsletter on timber topics mailed quarterly t landowners.

One company mentioned its policy of limiting out-of-pocket cost incurred on behalf of family members to $2,000 each year. The land owner is required to reimburse the company for additional costs.

Advantages to Firms

All firms agreed that creation of a tree farm family boosts th timber supply in the region around their mills. Most firms had alway succeeded in buying all the stumpage sold by their family members i the firm wanted it. Some firms occasionally did not get the timbe because a competitor offered more than it was worth to the firm o because the firm was unaware that the timber was available. In th latter case, the firm usually attributed its lack of knowledge abou an imminent sale to a failure to keep close contact with its family Half the firms had confidence that all owners would sell almost ex clusively to them; the others estimated that from 80 to 90 percent o the owners would do so.

A second benefit of the informal agreements is that the firm achieves improved forest management on private land in its procure ment region at small cost to the company. Only one firm deemed it t be "a pretty good cost to the company." Firms generally felt the ex pense of foresters' salaries for timber management on members' land is a worthwhile investment. About half the firms deemed that the time required of company officers and employees for the tree farm family program is small, and half considered it moderate.

Goodwill created in the landowner serves to enhance the com pany's reputation with the general public. All but one firm cited this benefit. About half the companies felt that owners who are community

leaders might help the company in solving problems of taxation, fire prevention or suppression, and trespass.

Individual firms cited one or more of the following additional benefits as stemming from their tree farm families.

Attention to the families gives a company added information about and ownerships, sales, land-use patterns, and land values—or at least makes it conscious of the influence of these elements on its business success.

The continuing relationship with the landowner gives the company more control over the timing of cuts than if the owner were planning the harvest solely at his own convenience. Also, if delays develop in the company's harvesting operations, chances are good that a family member will grant an extension of the cutting contract.

If the acreage and productivity per acre can be increased sufficiently, the company could reduce its capital investment in land and timber. One company's policy is to own no timberland at all and to let individual landowners shoulder the burden of taxes and other costs of management.

An even broader, though related, benefit was considered to be the political and economic advantage of keeping the large majority of land in private ownership by the general public. Money produced by such land goes into the owners' pockets and tends to assure a healthy economy, a consideration of "unmeasurable value."

Companies could benefit in their long-range plans for optimum location of woodyards by estimating the future volumes of timber to be produced from company lands and from landowners' tracts. In the interim, companies that buy through dealers could control the flow of timber to their dealers' woodyards.

Disadvantages to Firms

The creation, development, and maintenance of the family inevitably involves costs and disadvantages to the company. Each of the following disadvantages was cited by a different company.

The company is at the "mercy" of the landowner as to the actual management of his land. The owner may be unwilling to authorize operations that are essential for ideal land and forest management. Under the company's standard tree farm family agreements, company investment in these operations is "not worth a dime." Overcutting may be induced if the landowner wants all his merchantable timber harvested at once. Or there may be a delay in the availability of an owner's timber if he prefers to postpone the addition to his income beyond the current tax year. Also, increased logging costs may be incurred if the landowner is overzealous for aesthetics and wants a parklike appearance in his forest.

Distance and turnover of company foresters sometimes militates against close communication between the responsible forester and his family members. Many absentee owners find it hard to understand recommendations by phone or letter, and they delay decisions until their annual trip, often at Christmas time. When a forester responsible for maintaining the tree farm family is replaced, one firm noted that 2 to 3 years are needed for the new forester to develop adequate rapport with his family. Death of a family member also means that the forester has to take time to earn the heir's confidence.

A disadvantage in the eyes of another company is that it feels obligated to practice good forest management on family members' lands. Therefore, it is inhibited in its wood procurement operations on these tracts: when pressure is on for a large volume of wood, instead of being able to cut a high volume per acre—as it would on any other ownerships—the company refrains from taking all the merchantable timber on family lands.

Lack of control over price was also cited as a disadvantage of the agreements.

Conditions in Agreements

Conditions explicitly stated vary widely among companies, but almost all agreements at least implicitly include the following provisions.

The basic requirement is that the landowner grant first refusal rights to the company. This opportunity means allowing the company the first option to buy at market price any timber the owner intends to sell. In other words, after the owner obtains bids for his timber, he is expected to sell it to his family company at the price offered in the highest bid if the company is willing to buy it at that price. The company does not have to outbid its competitors; it has only to match the highest bid.

Another common condition is first refusal rights on the purchase of any land the owner might offer to sell in the future.

The landowner must also assure that he has good and merchantable title to the land. He must identify the boundaries of his property and pay the taxes on the land. He further agrees to allow the company access to his land and egress from it. In addition, one company requires that the landowner not hold it liable for damage or loss to his timber.

Companies accept responsibility for developing a management plan for each owner's forest acreage. Some of the plans are formal, written documents; others are oral understandings. This plan can include an inventory of the landowner's timber, a sketch map of predominant forest types, help in site preparation and planting, and recommendations for harvesting.

A rare specification is the maximum pulpwood volume the company will accept.

In agreements where the initial term is spelled out, up to 20 years is common, but a term of 2 to 10 years is acceptable to one firm. Usually either party can terminate the agreement at will, but sometimes 30 to 60 days' written notice and in one case 1 year's notice is required. One firm specified that the agreement is renewable yearly, realizing that this annual contact helps to maintain a healthy rapport with the landowner. Only one of the 11 firms requires the landowner to pay a maximum of 50 cents to $1 an acre for management costs if he cancels the agreement before the end of the term.

To Write or Not to Write?

A number of companies prefer unwritten agreements, believing their interests are best served by informality and reliance on the owner's good conscience. The risk of losing a few unconscionable owners' timber is generally considered small. When moral obligation conveyed through person-to-person trust is replaced by the less compelling obligation of abiding by the written word, the damage to company objectives is felt to be greater. Legal pressure may result in loss of precious goodwill.

Almost half the firms normally write some sort of agreement with each owner; a few write agreements with some owners but not with others. One company's policy is to write contracts only if more than 1,000 acres are involved. Another company usually writes agreements only if an owner asks for one. Some write agreements only at the time when cutting or planting is scheduled. Two companies had not written agreements before the end of 1973, but because of competition from other companies, they are planning to develop some.

The written agreements themselves vary. Some specify exactly what each party is expected to do; some are less detailed. Many companies prefer an intermediate degree of documentation, something between a fully detailed written agreement and a simple oral agreement. They combine an inviting, friendly letter of intent with a management plan describing what the company proposes to do on the owner's property, given the opportunity. Some companies merely provide the owner with written guidelines or a schedule indicating their intentions and the necessity for his cooperation; owner concurrence is especially important when he will incur out-of-pocket costs. One company's written agreement is a statement that either party can veto or postpone action proposed by the other; the purpose is to maintain a warm relationship despite the fact that company goals and time schedules will not always coincide with the landowner's desires.

For understanding and acceptance of a firm's proposed actions agreements, management plans, letters and other documents shoul be written in laymen's language, using everyday terms that are clea and easily understood.

Formal Contracts Versus Tree Farm Families

When each firm was asked whether it had ever tried to conver any of its tree family members to formal contracts or leases, the repl was invariably negative. Failure to attempt the conversion, however does not mean that firms would not like to have some, if not all, of th owners under lease or contract. A few firms created their tree farn families precisely because some owners they wished to draw into com mitment were unwilling to subscribe to any more binding arrangement The tighter the agreement, the harder it would be to enroll landowners so the idea of contracts was rejected.

One firm offers long-term leases initially to anyone who will no sell his land outright. Two other firms were planning to develop forma contracts but were not yet ready to offer them to landowners; they wil continue the tree farm family agreements, however, even after the institute the contracts. Both of them had found that some owners wan the feeling of security and continuity that goes with long-term con tracts. Sometimes such owners are middle-aged or elderly people wh want to feel that the company-administered forest management wil continue after they die. Sometimes they are the heirs of such an owner they have enough of an emotional involvement in the property to wan to keep it managed as the late owner had chosen, but they do not wan to participate as much in the management and decision-making as i implicit in tree farm family agreements. The long-term leases relieve them, of course, of such participation.

Conclusion

A stock market investor spreads his risks and hedges against ad versity by maintaining a diversified portfolio. Similarly, a firm whos business requires wood procurement generally is well advised to own some forest land from which to extract timber at appropriate times to buy timber on the open market at favorable prices from landowner who have borne the risks of timber production and the burdens of taxe and insurance, and perhaps to obtain timber from any of a number o intermediate arrangements. One of these is the tree farm family.

The tree farm family is regarded as a success by nearly all th companies. Most of the firms interviewed are so well pleased wit their families that they wish to continue enlarging them. None wis to eliminate their families. Some firms, however, would gladly sub

'titute long-term contracts or ownership in fee simple for some of the amily arrangements so that they could gain tighter control over the orest resources.

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Economics of Short-Rotation Sycamore

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Economics of Short-Rotation Sycamore

G. F. Dutrow and J. R. Saucier [1]

Short-rotation sycamore was most profitable with good sites, wide spacings, and cutting cycles of 4 or 5 years. Unless costs can be substantially reduced and markets expanded, the system appears to be economically feasible for industrial landowners only. In most cases, annual income from sycamore did not compare favorably with income from agricultural crops.

Additional keywords: *Platanus occidentalis*, simulation, yields, costs, returns, fertilization, genetic improvement.

The demand for wood products is increasing; yet forest land is being lost to competing uses. Forest managers and wood fiber processors are therefore seeking means of expanding raw material output from a declining resource base. One proposed solution is short-rotation sycamore.

The economics of short-rotation sycamore have been analyzed previously (Dutrow 1971); in that study computer simulations were based on data from one seedling crop (fig. 1) planted in Georgia and one subsequent coppice crop (fig. 2). Recent technological changes in processing juvenile fiber favor expanded markets for particle-based and reconstituted wood products. These advances along with improved silvicultural information justify a reexamination of the economic feasibility of short-rotation sycamore.

Data supporting detailed silvicultural recommendations are still largely unavailable because widespread cultivation of short-rotation sycamore has yet to occur. However, two additional coppice crops since the original plantings showed undiminished yields; data from these crops are now available for further analyses.

The present paper reexamines the economics of short-rotation sycamore. The new simulations were based on data for the four crops—one seedling and three coppice. The analyses relate economic considerations such as costs, yields, and prices to silvicultural features such as site, survival, fertilization, and potential for genetic

[1] Dutrow, an economist with the Forest Service—USDA, was formerly at the Southern Forest Experiment Station, New Orleans, La., and is now at the Southeastern Forest Experiment Station, Athens, Ga. Saucier is a wood scientist at the Southeastern Forest Experiment Station at Athens.

Figure 1.—*Four-year-old sycamore seedling crop.*

manipulations. Comparisons are drawn between revenues from sycamore and those from agricultural crops, and implications for future research and applications are discussed.

Innovations in Processing Juvenile Sycamore

Tests in Georgia found sycamore suitable for producing corrugating medium, linerboard, quality bond paper, and newsprint (Georgia Forest Research Council 1973). One advantage of harvesting young sycamore is the utilization of the entire tree. The harvester can convert stem, branches, bark, and leaves into chips in a single operation. Screens developed for use with chip-harvesting systems

ıay speed industry acceptance of short-rotation sycamore. The creens separate dirty chips into nearly clean wood; bark, leaves, rash and fines; and very fine bark and grit. The poor-quality ma-erials might be marketed as low-cost fuel and mulch; the clean ood would be converted into pulp.

Pulp from juvenile sycamore requires smaller amounts of bleach-ıg and cooking liquids, lower pressures and temperatures, and horter cooking cycles than conventional hardwoods (Ribe 1974). n a pilot study in which fiberboard was manufactured by both wet nd dry processes (Laundrie and Fahey 1973), product quality im-roved with crop age; however, even 2-year-old sycamore produced oards comparable to products from conventional hardwoods. Six-ear-old sycamore was found suitable for particleboard manufacture Rice 1973).

There are a few shortcomings to processing young sycamore. Because juvenile wood has a lower specific gravity than mature

Figure 2.—*Three-year-old sycamore coppice crop.*

wood, pulp yields from a given volume of juvenile wood are small and expenditures for production, procurement, transportation, a storage of a given amount of wood are greater. Unlike many you hardwood species, however, juvenile sycamore has a relatively hi specific gravity and long fibers—approximately 80 to 90 perce of mature wood values (McGovern 1973, Saucier and Ike 196 Improvements both in tear and bursting strength and in pulp yiel would enhance marketability.

Research should be directed at minimizing these detrimen Development of genetic stock that grows faster and has bett processing qualities would substantially reduce the existing defi encies.

Costs

Costs to establish plantations are categorized as fixed, variab or annual. Fixed costs remain constant regardless of site, spacing, cutting cycle. The major fixed cost of production is site preparatio Sites should be cleared, raked, burned, and disked prior to setti out seedlings or cuttings. Costs simulated here were based on da from industry. Where timber clearing or other extensive conversi was unnecessary, site preparation costs were $40 per acre; wi conversion, an additional $35 per acre was charged. This analys evaluated the $75 per acre combined cost.

Two additional fixed costs were for weed control and initi fertilization. Whether weed control is accomplished chemically by cultivation, current costs are $25 per acre; the cost of initi fertilization is $50 per acre. Energy crises and soaring chemic costs may inflate the cost of both chemical control and fertilizatio Falling net revenues might be avoided by using cultivation and b developing genetically improved stock that offers adequate yiel without fertilization.

The final fixed costs included miscellaneous expenditures f insect control, trucking, and management and were estimated at $ per acre. Total fixed costs excluding land purchase were $15 regardless of site, spacing, or cutting cycle.

Variable costs are influenced by spacing and planting techniqu Costs of seedlings or cuttings, planting charges, and labor rates var directly with spacing. Spacings evaluated here were 1 by 4, 2 by 4 by 4, and 6 by 4 feet; seedling requirements ranged from approx mately 11,000 per acre for 1- by 4-foot spacing to 2,000 seedlin per acre for 4- by 6-foot spacing. Seedling costs were set at $1 per thousand. Cost of planting equipment was set at $5 per thousan seedlings, and supervisory and labor costs were set at $7.70 pe

housand. The total variable cost was $22.70 per thousand seedlings. 'osts for each spacing were,

Spacing (feet)	Variable costs	Total establishment costs (variable plus fixed)
1 by 4	$247.20	$402.20
2 by 4	123.60	278.60
4 by 4	61.79	216.79
6 by 4	41.20	196.20

'hese figures emphasize the economic impact of spacing. In the ensest spacing, variable costs were almost $250—more than half ıe establishment costs.

The earlier evaluation of short-rotation sycamore suggested that orizontal placement of cuttings might reduce the cost of providing eedlings and setting them in the soil (Dutrow 1971). Experiments t the Forestry Sciences Laboratory in Athens, Georgia, verified ıe cost reductions, but the two plantations established in this man- er were lost to spring flooding. Horizontal planting would therefore e advantageous only where sites are free of flooding.

In addition to the fixed and variable costs, periodic expenses ccur. An additional $0.75 per ton was charged for harvesting, 1.50 per ton for hauling, and $50 per acre for refertilization after arvesting. Another periodic cost—the reestablishment of root tocks to sustain coppice crops—was set at initial establishment costs ıinus the $35 per acre cost of conversion. An additional $2 per cre per year was charged to cover taxes, fire protection, and gen- ral management.

The combined harvesting and hauling costs for chips ($2.25 per ɔn) were reported by industrial foresters experimenting with short- otation sycamore and by equipment manufacturers. The costs epresent a substantial savings over conventional logging for bolts. ıt three tons of chips per cord, sycamore can be harvested and elivered to an industrial receiving point for $6.75 per cord in ontrast to at least $15 per cord for bolts (Bellamy 1974, Myers 1973). 'he savings accrue largely from substituting machinery for man- ower. Short-rotation sycamore can be clearcut by a machine similar ɔ a silage cropper. Harvesting, chipping, and then blowing the chips ıto a tractor-drawn wagon or truck would be a single operation for vhich the technology and even a prototype machine already exist. Iowever, a substantial acreage would have to be converted to short- otation sycamore to justify the expense of mechanization. Two ıachines would cover the year-round needs for 10,000 acres of ycamore plantations (Dutrow 1971).

Physical Yields

Data from the two most recent coppice crops and from other sycamore studies have confirmed that site selection is the most important decision in establishing sycamore plantings (Briscoe 1969, Dutrow 1971). Aeration, alkalinity, and drainage are particularly significant. Sycamore grows best on well-aerated, fertile, mildly acid to mildly alkaline soils with sufficient drainage but with some ground water in the root zone. Poorly drained coastal plain sites severely inhibited growth, whereas similar sites that were well-drained supported vigorous growth (Saucier et al. 1972).

Regardless of spacing and rotation length, yields varied drastically between good and average sites (table 1). Both soils are undifferentiated alluvium, but they differ greatly in physical properties. The good site has approximately 40 percent sand and is classified as sandy clay loam. The average site has about 25 percent sand and is classified as silty clay.

Yields from the initial seedlings and those from the first three coppice crops showed that only the 3-, 4-, and 5-year rotations and

Table 1.—*Physical yields of short-rotation sycamore*

Management options	Good site	Average site
	M lbs. per acre (green weight)	
4- by 4-foot spacing		
3-year cutting cycle		
Seedling yield	15.7	12.0
Coppice yields [1]	25.5	15.0
4-year cutting cycle		
Seedling yield	26.0	20.0
Coppice yields	38.0	23.0
5-year cutting cycle		
Seedling yield	35.0	27.5
Coppice yields	51.2	35.0
6- by 4-foot spacing		
3-year cutting cycle		
Seedling yield	15.0	10.5
Coppice yields	24.0	12.0
4-year cutting cycle		
Seedling yield	22.0	15.0
Coppice yields	36.0	21.0
5-year cutting cycle		
Seedling yield	30.0	20.0
Coppice yields	50.0	35.0

[1] Amounts shown indicate average yield per harvest. With seven coppice crops, it is assumed that yields would decline by 8 percent at age 24 for 3-year rotations, 10 percent by age 32 for 4-year rotations, and 12 percent by age 40 for 5-year rotations.

the 4- by 4- and 6- by 4-foot spacings were economic (table 1). Data were gathered and analyzed for shorter rotations (1 and 2 years) and closer spacings (1 by 4 and 2 by 4 feet), but the yields did not offset establishment and periodic costs, even with a wide range of price assumptions.

In the analysis, options that showed a financial loss were discarded. A gradual yield dimunition was simulated in which the decline was set at 8 percent for the 3-year rotation, 10 percent for 4 years, and 12 percent for 5 years.

Good survival rates as well as favorable sites are crucial for achieving simulated yields. Unlike many planted hardwoods, sycamore plantations show high survival rates. Steinbeck et al. (1972) reported survival rates of more than 90 percent whether planting was by hand or machine. Survival rates may be affected by trampling from browsing animals and by insect damage, fire, and rodents. However, neither deer nor domestic livestock seem to prefer sycamore as browse; furthermore, studies of sycamore planted in the Mississippi Delta showed that insect damage to foliage did not seriously affect survival. Fire and rodents offer potential but minor hazards. Kennedy (1975) reports survival rates above 85 percent for coppice crops. Kormanik et al. (1973) obtained similar results after second and third cutting cycles.

Even with satisfactory survival rates, yields are sensitive to cutting cycle. With extremely short cycles (1 or 2 years) yields are adversely affected by unfavorable weather (Ribe 1974). With longer rotations—especially at close spacings—diameter and height growth reportedly decline (Kormanik et al. 1973); however, an offsetting benefit is the greater percentage of stem wood, which has more desirable processing features than crowns and limbs.

Yields are subject to change through genetic manipulation of growing stock. Short rotations facilitate a rapid evaluation of genetically altered stock.

Although fertilization increases yields, nutrient applications might possibly be reduced without unacceptable crop losses, even if the stands have been responding to treatment. Ribe (1974) emphasizes that large quantities of organic matter and nutrients are recycled naturally through the soil from annual litter. He also advocates cost reduction by fertilizing with municipal sewage or pulpmill sludge.

Yields may also be affected by the time of harvesting. Year-round harvesting may reduce yields. Steinbeck et al. (1972) harvested plantations in winter, early spring, late summer, and in fall. Although all stumps resprouted, some were killed by early frost, and some sprouting was delayed until after winter.

Prices and Options

In the absence of a short-rotation sycamore stumpage market, crop values are necessarily speculative and are here based on values of analogous wood products. The hardwood chip market was the basis for deriving sycamore stumpage prices. Harvesting costs were deducted. Bark free chips from green hardwood were worth $10 per ton at delivery in 1974 (Bellamy 1974). It is unlikely that the mixture of bark, twigs, leaves, and chips characteristic of short-rotation sycamore would bring more than $5 per ton after harvesting and hauling costs are deducted. Prices assumed in the simulation were $5 per ton for stumpage and $10 per ton at the point of delivery after harvesting costs were deducted.

The costs, yields, and prices expected from various cutting cycles and spacings were combined in a variety of options to calculate present net worths, equivalent annual incomes, benefit/cost ratios, and internal rates of return (Row 1974). The analyses assumed eight harvests with gradually declining productivity and a discount rate of 8 percent. The questions considered were:

—How do different sites, cutting cycles, and spacings affect profitability of short-rotation sycamore investments for the nonindustrial landowner and for industry?

—How sensitive are profits from sycamore plantations to variations in stumpage prices?

—How many coppice crops are needed to make the investment pay?

—Will genetic improvements be profitable?

—Can sycamore compete with agricultural crops grown on similar soils?

Implications for Nonindustrial Landowners

Yield differences between good and average sites were critical for nonindustrial landowners. Regardless of spacing or cutting cycle, average sites were unprofitable when stumpage was $5 per ton.

Good sites showed promise (table 2). Yields were sensitive to cutting cycle and spacing. With 5-year cutting cycles and spacings of either 4 by 4 or 6 by 4 feet, favorable sites provided present net worths of nearly $100 per acre, equivalent annual incomes of about $8 per acre, benefit/cost ratios of nearly 1.3, and internal rates of return of 11 percent. Though yields increased with cutting cycle, the gain from 4 to 5 years was less than that from 3 to 4 years, an indication that revenues rise at a decreasing rate.

Table 2.—*Values with stumpage prices at $5 per ton on good sites* [1]

Spacing and cutting cycle	Present net worth	Equivalent annual income	Benefit/ cost	Internal rate-of-return
	---- $/acre ----		$/$	*Percent*
4 by 4 feet				
3 years	N	N	0.88	6
4 years	45.45	3.97	1.12	10
5 years	96.89	8.13	1.28	11
6 by 4 feet				
3 years	N	N	0.88	5
4 years	34.40	3.01	1.10	9
5 years	92.79	7.78	1.28	11

[1] On average sites, all values were negative (N).

Returns were always greater with 4- by 4-foot spacings than with those of 6 by 4 feet. The closer spacing apparently takes better advantage of site potential than the wider one.

Implications for Industry

Industrial landowners capable of processing short-rotation sycamore in company facilities face brighter prospects. A $10 per ton sale price at delivery point after an internal charge of $2.25 per ton for harvesting and hauling represents an imputed opportunity cost for industry, if it is assumed that chips are available on the open market for $10 per ton. If the wood could be grown on company lands, harvested, and hauled to the delivery point for less than $10 per ton, sycamore would be a profitable investment for industry.

The 4- or 5-year cycles were necessary for economic optimization (table 3). On favorable sites, present net worth exceeded $300 per acre with a 5-year cutting cycle. Regardless of spacing, 3-year rotations on average sites showed losses.

Industries dependent on wood fiber as a primary raw material might view losses differently than nonindustrial landowners. Short-rotation sycamore promises high wood fiber output per acre and provides the release of additional acres for producing timber for saw logs and veneer logs and for recreation and other high-value uses.

Sensitivity of Profits to Stumpage Prices

A frequently voiced concern is the minimum price at which sycamore stumpage can be sold at a profit. Long hauling distances and stringent requirements for clean chips might result in stumpage values of only $3 per ton, but harvesting economies, short hauling distances, and techniques for processing various kinds of chips might

Table 3.—*Values with delivered price of $10/ton on good and average sites*

Site, spacing, and cutting cycle	Present net worth	Equivalent annual income	Benefit/ cost	Internal rate-of-return
	— — — $/acre — — —		$/$	*Percent*
Good site				
4 by 4 feet				
3 years	144.58	13.73	1.25	14
4 years	268.10	23.45	1.47	16
5 years	330.85	27.75	1.59	17
6 by 4 feet				
3 years	133.61	12.69	1.24	14
4 years	240.15	21.00	1.45	16
5 years	313.51	26.29	1.60	17
Average site				
4 by 4 feet				
3 years	N [1]	N	.87	4
4 years	38.38	3.36	1.08	10
5 years	134.63	11.29	1.27	12
6 by 4 feet				
3 years	N	N	.77	N
4 years	4.83	.42	1.01	8
5 years	116.50	9.77	1.25	12

[1] N = negative value

raise the price as high as $10 per ton. To provide a range of values, stumpage prices from $3 to $10 per ton were analyzed (table 4). In the analysis, price was assigned to stumpage only, and no allowance was made for harvest or haul expenses. On good sites, the longer cutting cycles were profitable at prices as low as $4 per ton (table 4). Present net worth soared to over $500 per acre at $10 per ton stumpage prices.

Optimal Number of Coppice Crops

In determining how many coppice crops the initial rootstock can support before revenues exceed costs, an assortment of sites, spacings, and prices was analyzed (table 5). The number of successful rotations was varied from one (initial planted seedlings or cuttings) to eight (one seedling and seven coppice crops). With good sites and 5-year cutting cycles, the investment was profitable with as few as three crops for stumpage at $5 per ton and two crops with a delivered price of $10 per ton. In both cases profits increased with each additional coppice crop.

Profit from Genetic Improvement

In the analysis, it was assumed that planting stock yielding 10 percent above standard levels could be obtained; results were also obtained for improved planting stock that would maintain

Table 4.—*Economic implications of various stumpage prices*

Site category and spacing	Stumpage price ($/ton)	Present net worth ($/acre) at various cutting cycles [1]			Equivalent annual income ($/acre) at various cutting cycles		
		3 years	4 years	5 years	3 years	4 years	5 years
Good site							
4 by 4 feet	3	N [2]	N	N	N	N	N
	4	N	N	$ 8	N	N	$ 1
	5	N	$ 45	97	N	$ 4	8
	6	$ 24	129	186	$ 2	11	16
	7	90	213	274	9	19	23
	8	169	297	363	16	26	30
	9	241	381	452	23	33	38
	10	313	465	540	30	41	45
6 by 4 feet	3	N	N	N	N	N	N
	4	N	N	$ 9	N	N	$ 1
	5	N	$ 34	93	N	$ 3	8
	6	$ 20	112	177	$ 2	10	15
	7	88	190	260	8	17	22
	8	156	267	344	15	23	29
	9	224	345	428	21	30	36
	10	293	423	512	28	37	43
Average Site							
4 by 4 feet	3	N	N	N	N	N	N
	4	N	N	N	N	N	N
	5	N	N	N	N	N	N
	6	N	N	$ 31	N	N	N
	7	N	$ 3	94	N	$0.26	N
	8	N	57	157	N	5	N
	9	N	111	220	N	10	$18
	10	$ 37	165	283	$ 4	14	24
6 by 4 feet	3	N	N	N	N	N	N
	4	N	N	N	N	N	N
	5	N	N	N	N	N	N
	6	N	N	$ 22	N	N	$ 2
	7	N	N	80	N	N	7
	8	N	$ 21	138	N	$ 2	12
	9	N	68	196	N	6	16
	10	N	115	254	N	10	21

[1] Number of rotations = 8
[2] N = negative value

acceptable growth rates (80 percent of the standard) without fertilization (fig. 3). On good sites, both genetic improvement options appeared advantageous. With planting stock that increased yields by 10 percent, net worths for the 4-year rotations doubled, and those for the 5-year cycles increased by 50 percent at both spacings. An additional year of growth is apparently necessary to realize the full financial potential of improved planting stock.

Table 5.—*Economics of varying the number of harvests from a single seedling planting*

Site category, price, and spacing (feet)	Number of rotations	Present net worth ($/acre) at various cutting cycles			Equivalent annual income ($/acre) at various cutting cycles		
		3 years	4 years	5 years	3 years	4 years	5 years
Good site	1	N [1]	N	N	N	N	N
$5/ton	2	N	N	N	N	N	N
stumpage price	3	N	N	$ 6	N	N	$ 1
4 by 4 feet	4	N	N	41	N	N	4
	5	N	$ 8	64	N	$ 1	6
	6	N	23	78	N	2	7
	7	N	34	88	N	3	8
	8	N	45	97	N	4	8
6 by 4 feet	1	N	N	N	N	N	N
	2	N	N	N	N	N	N
	3	N	N	$ 6	N	N	$ 1
	4	N	N	39	N	N	4
	5	N	$ 0	61	N	$ 0	6
	6	N	14	75	N	1	7
	7	N	23	84	N	2	7
	8	N	34	93	N	3	8
$10/ton							
delivered price	1	N	N	N	N	N	N
4 by 4 feet	2	N	$ 14	$ 77	N	$ 2	$11
	3	N	98	172	N	13	20
	4	$ 36	157	233	$ 5	18	24
	5	73	199	274	8	20	26
	6	100	228	300	11	22	27
	7	121	249	317	12	23	27
	8	145	268	331	14	23	28
6 by 4 feet	1	N	N	N	N	N	N
	2	N	$ 4	$ 68	N	$ 1	$10
	3	N	82	160	N	11	19
	4	$ 35	137	219	$ 5	16	22
	5	68	176	258	8	18	24
	6	93	203	284	10	19	25
	7	111	222	300	11	20	26
	8	134	240	314	13	21	26
Average Site [2]	1	N	N	N	N	N	N
$10/ton	2	N	N	N	N	N	N
delivered price	3	N	N	$ 40	N	N	$ 5
4 by 4 feet	4	N	N	77	N	N	8
	5	N	$ 6	101	N	$ 1	9
	6	N	19	116	N	2	10
	7	N	28	126	N	3	11
	8	N	38	135	N	3	11

[1] N = negative value

[2] All values for stumpage at $5 per ton were negative on average sites.

Table 5.—*Economics of varying the number of harvests from a single seedling planting* (continued)

Site category, price, and spacing (feet)	Number of rotations	Present net worth ($/acre) at various cutting cycles			Equivalent annual income ($/acre) at various cutting cycles		
		3 years	4 years	5 years	3 years	4 years	5 years
6 by 4 feet	1	N	N	N	N	N	N
	2	N	N	N	N	N	N
	3	N	N	$ 22	N	N	$ 3
	4	N	N	59	N	N	6
	5	N	N	82	N	N	8
	6	N	N	98	N	N	9
	7	N	N	108	N	N	9
	8	N	$ 5	116	N	$0.4	10

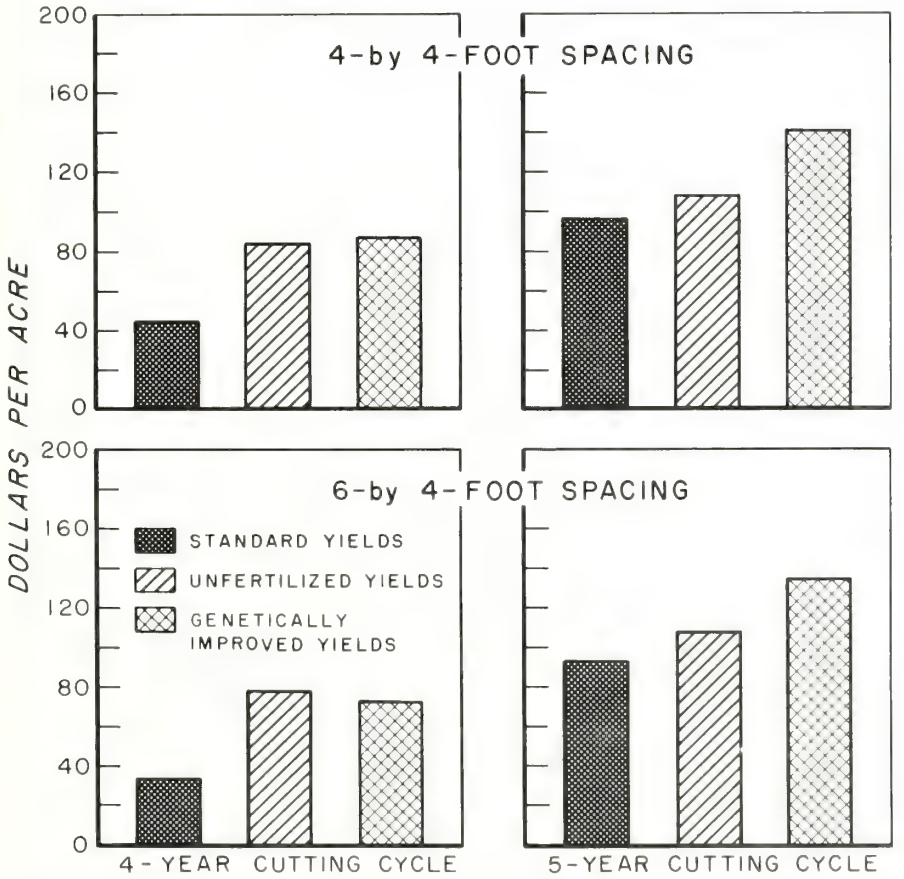

Figure 3.—*Present net worth ($/acre) of standard yields, unfertilized yields, and genetically improved yields of short-rotation sycamore planted on good sites. Assumptions: $5/ton stumpage price, 8 harvested crops, 8 percent rate-of-return.*

On average sites, yields without fertilization were the least costly, and net worth was positive with a 5-year cutting cycle at both spacings. Therefore, on average sites, it would pay to invest in improved planting stock that would give satisfactory yields without fertilization.

Can Forestry Compete with Agricultural Crops?

The landowner confronted with the choice of planting sycamore and selling the stumpage at $5 per ton or planting agricultural crops has an easy decision. Best annual returns from sycamore stumpage—$8.13 per acre—are less than half the returns anticipated from corn or grain, the least profitable agricultural options (table 6). For industrial landowners who can expect delivered prices of $10 per ton, however, sycamore can compete with the less profitable agricultural crops.

Table 6.—*Annual net returns from short-rotation sycamore* [1] *and agricultural crops for the Piedmont area of Georgia (Wise 1974)*

Crops	Annual net return ($/acre)
Bermuda hay	117.80
Oats and soybeans	58.65
Oats and grain sorghum	45.96
Soybeans	44.24
Cotton	44.04
Wheat	35.11
Sycamore (4- by 4-foot spacing; $10/ton delivered)	27.75
Sycamore (6- by 4-foot spacing; $10/ton delivered)	26.69
Oats	24.82
Corn	20.79
Grain Sorghum	20.48
Sycamore (4- by 4-foot spacing; $5/ton stumpage)	8.13
Sycamore (6- by 4-foot spacing; $5/ton stumpage)	7.78

[1] Good site, 5-year cutting cycle

Conclusions

Short-rotation sycamore promises industrial owners a profitable way to supply wood fiber for processing facilities. Good sites and 4- or 5-year cutting cycles appear most advantageous, regardless of price, spacing, or number of crops obtained. Genetics research to increase yield or decrease the need for fertilization would enhance the financial feasibility of short rotation sycamore.

Private landowners dependent on stumpage sales for profit face disappointment. The lack of established markets, the need for large

capital outlays, and sensitivity of profits to cost, site, and yield interactions largely preclude short-rotation sycamore as a recommended forestry investment for nonindustrial landowners.

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1976. Economics of short-rotation sycamore. South. For. Exp. Stn., New Orleans, La. 16 p. (USDA For. Serv. Res. Pap. SO-114)

Short-rotation sycamore was most profitable with good sites, wide spacings, and cutting cycles of 4 or 5 years. Unless costs can be substantially reduced and markets expanded, the system appears to be economically feasible for industrial landowners only. In most cases, annual income from sycamore did not compare favorably with income from agricultural crops.

Additional keywords: *Platanus occidentalis*, simulation, yields, costs, returns, fertilization, genetic improvement.

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Site Characteristics Influence Relative Performance Of Loblolly and Slash Pine

Eugene Shoulders

Southern Forest Experiment Station
Forest Service
U. S. Department of Agriculture

1976

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Site Characteristics Influence Relative Performance of Loblolly and Slash Pine

Eugene Shoulders [1]

Loblolly pine survived outplanting about 10 percent better than slash pine on a broad array of pine sites in Louisiana and Mississippi. In the 15 years following planting, 21 percent of loblolly and 31 percent of slash boles developed fusiform rust cankers. In both species, the disease killed about one-third of the pines that developed stem infections. Infections were more frequent on intermediate than on wet or dry sites. In volume and height through age 15 years, slash grew better than, or as well as, loblolly on essentially level sites with poorly to imperfectly drained silty soils. The two grew about equally well in most other circumstances. Projections of heights to age 25 years indicate that slash will maintain its advantage over loblolly on flat, wet sites but that loblolly should by then equal or surpass slash in growth and yield on intermediate and dry sites. Site characteristics associated with 15-year heights of dominant and codominant trees, in descending order of importance, were rainfall, slope, and soil texture.

ADDITIONAL KEYWORDS: *Pinus elliottii, Pinus taeda,* soil-site relationships, survival, height growth, volume increment, fusiform rust infection.

What species should I grow here? This question is asked and answered annually for about a million acres of pine forest in 12 Southern States (USDA FS 1970, 1971, 1972, 1973, 1975). On pine sites in the tier of States from Texas to Georgia, the choice is usually whether to plant loblolly *(Pinus taeda* L.) or slash *(P. elliottii* Engelm.) pine. To date, researchers have provided only fragmentary information to the forest manager on the consequences of his decision (Muntz 1948, Wakeley 1954, Shoulders 1959, 1970, Brightwell 1971, Watson and others 1973, Cole 1975). Clearly, then, the subject "choice-of-species" is as timely today as it was in the mid-1950's when the Southern Forest Experiment Station, with the help of both public and private forestry organizations, established 113 southern pine species trials in Louisiana and Mississippi.

This paper compares loblolly and slash pine performance through age 15 years. Factors evaluated are first-year survival, occurrence and consequence of fusiform rust *(Cronartium fusiforme* Hedgc. and Hunt ex. Cumm.) infection in the bole, height of the dominant stand, and mean annual increment expressed as basal area, total cubic volume, and merchantable cubic volume. It also reports in a separate section relationships between 15-year heights of the two species and site characteristics. Readers may wish to skip this section if their main interest is the relative performance of the two species on a wide variety of sites.

SITES

Installations were widely distributed on open forest land in the two States south of a line formed by extending Louisiana's northern boundary across Mississippi (fig. 1). Collectively, they represented a wide range of site conditions (table 1). When the installations were established, or soon thereafter, the sites were classified as wet, intermediate, or dry on the basis of field examination of the soil. Soils of wet and intermediate sites correspond to Zahner's (1958) azonal and zonal soils, respectively. Dry site soils have no real counterparts in Zahner's site index work.

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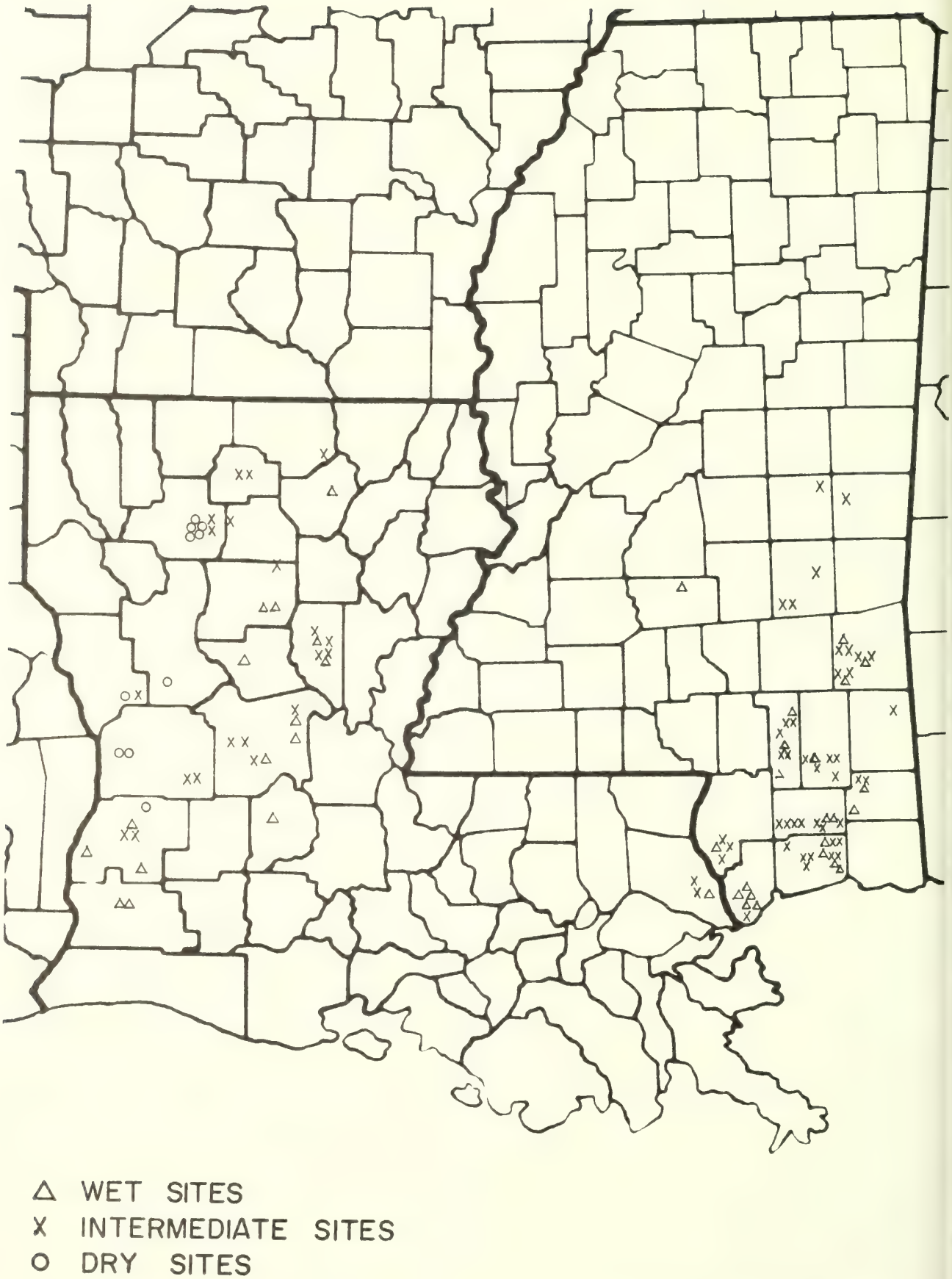

Figure 1.—*Locations of outplantings.*

Table 1.—*Variation in selected characteristics of the planting sites*

Item	Unit of measure	Min.	Max.
Wet sites			
Latitude	Degrees	30.2	32.5
Longitude	Degrees	88.8	93.7
Average annual rainfall	Inches	52	72
Average growing season rainfall	Inches	24	46
Slope	Percent	0	7
Organic matter in A_1 horizon	Percent	0.8	8.3
Texture of 6-10 inch layer			
Sand	Percent	10	68
Silt	Percent	22	67
Clay	Percent	6	30
Texture of 16-20 inch layer			
Sand	Percent	9	62
Silt	Percent	20	65
Clay	Percent	6	51
Intermediate sites			
Latitude	Degrees	30.1	32.8
Longitude	Degrees	88.1	93.5
Average annual rainfall	Inches	47	72
Average growing season rainfall	Inches	24	46
Slope	Percent	1	13
Organic matter in A_1 horizon	Percent	0.3	4.0
Thickness of A horizon	Inches	3	25
Texture of A horizon			
Sand	Percent	20	89
Silt	Percent	6	65
Clay	Percent	5	22
Texture of B horizon			
Sand	Percent	13	85
Silt	Percent	4	49
Clay	Percent	11	56
Dry sites			
Latitude	Degrees	30.8	32.3
Longitude	Degrees	93.0	93.4
Average annual rainfall	Inches	46	56
Average growing season rainfall	Inches	24	28
Slope	Percent	2	11
Organic matter in A_1 horizon	Percent	0.2	1.0
Texture of 6-10 inch layer			
Sand	Percent	76	92
Silt	Percent	5	19
Clay	Percent	2	8
Texture of 16-20 inch layer			
Sand	Percent	73	94
Silt	Percent	3	17
Clay	Percent	3	10
Texture of 36-42 inch layer			
Sand	Percent	66	94
Silt	Percent	1	18
Clay	Percent	2	24

Wet site soils lacked prominent, abrupt changes in color or texture within the surface 3 or 4 feet. These soils remain submerged or saturated with water during wet periods, especially in winter. They range in internal drainage from very poor to moderately good.

The main distinguishing characteristic of intermediate sites was that the soils had well defined horizons, which differed from each other in both texture and color. These soils are moderately well to well drained.

The dry sites had a thick surface layer of coarse sand to sandy loam soil, which might or might not grade into somewhat heavier material below a depth of 3 feet. The soils have good to excessive internal drainage and a limited capacity to store readily available moisture.

DESIGN OF THE STUDY

Three plots of each species were planted at each location in a randomized block design. Planting interval was 6 feet within and between rows. West of the Mississippi River, gross plots contained 11 rows of 11 trees; in Mississippi and the Florida Parishes of Louisiana, they contained 12 rows of 12 trees each. First-year survival was computed from data for the gross plots. All other data were obtained from the area occupied by the center 49 or 64 planting positions.

PLANTING STOCK

Seedlings for the study were grown in State and Federal nurseries in Louisiana and Mississippi. Loblolly pine seedlings planted east of the Mississippi River were from seed lots collected in Mississippi, and those planted west of the River were from Louisiana seed lots. Slash pine seedlings for more than 80 percent of the plots were produced from seed collected in south Mississippi or the Florida Parishes of Louisiana. Seed for the remaining stock was obtained from a Georgia dealer. No genetically improved seed was used.

The stock was graded by Wakeley's (1954) rules, and healthy, uninjured morphological Grade 1 and 2 seedlings were accepted for planting. Even so, the slash stock planted west of the River in 1955 appeared to have been grown in over-dense beds, which probably reduced its potential to survive.

PLANTING AND REPLANTING

Nineteen of the installations were planted in January 1954, 42 in 1955, 38 in 1956, 12 in 1957, and 2 in 1958. To minimize survival effects on yield, mortality was replaced after 1 year, as follows. In Mississippi and the Florida Parishes of Louisiana, survivors on inadequately stocked plots were destroyed, and plots were completely replanted. A few plots were destroyed and replanted more than once. In Louisiana west of the River, individual dead or missing seedlings were replaced with 1-0 nursery stock, or the entire outplanting was destroyed and replanted. Replacement trees became a part of the established stand if they survived but were not included in the computation of first-year survival.

MEASUREMENTS AND ANALYSIS OF DATA

Survival was inventoried at the end of the first growing season. Subsequent inventories when trees on most plots in an installation were 2 or 3, 10, and 15 years old provided information on stocking, growth and yield, and field infections of fusiform rust.

Soil in each block of each installation was sampled and analyzed for the properties listed in table 1. In addition, one-third and 15 atmosphere moisture percents were determined for the 16-20 inch layer of wet site soils, the B horizon of intermediate soils, and the 16-20 and 36-40 inch layers of dry site soils. These properties had been identified as the physical soil characteristics most likely to be associated with tree growth (Coile 1952, Zahner 1958).

Latitude and longitude of each installation were scaled from maps. Rainfall information was compiled from U. S. Weather Service records for weather stations nearest to each installation.

One to three blocks in an installation contributed data on first-year survival (table 2). Fewer plots were available for assaying heights, growth and yield, and fusiform rust infection because no plot having less than 20 percent of the original planting spaces occupied at the last inventory or with less than three-fourths of the stand in trees of the designated species was used in these evaluations. (Errors in replanting were responsible for trees of the wrong species being present.) Plots which were seriously damaged by wildfire or hurricanes were also excluded. In addition, no plot was used in basal area, volume, or fusiform rust summaries if more than one-third of the trees present at age 2 or 3 years had died from causes other than fusiform rust infection of the main bole. And plots of both species in a block had to meet these criteria for data from the block to be used.

Table 2.—*Number of installations supplying information on survival, growth, and yield of loblolly and slash pine*

Site class and stand characteristic	Installations with—			Total installations
	1 block containing both species	2 blocks containing both species	3 blocks containing both species	
	Number			
Wet sites				
First-year survival	1	2	35	38
Height of dominant stand	6	2	19	27
Fusiform rust infection	2	4	12	18
Growth and yield	2	4	12	18
Intermediate sites				
First-year survival	6	6	53	65
Height of dominant stand	8	10	32	50
Fusiform rust infection	9	13	23	45
Growth and yield	9	13	23	45
Dry sites				
First-year survival	0	0	10	10
Height of dominant stand	1	2	7	10
Fusiform rust infection	2	4	3	9
Growth and yield	2	4	3	9

Diameters (at breast height) and total heights of all trees were measured at age 10 years. At age 15, the inventory included measurement of diameters of all trees and of total heights and upper stem dimensions of 12 randomly selected sample trees per plot. Total heights of other randomly selected trees were measured if they were needed to provide a sample of at least 10 dominant and codominant trees on each plot for estimating average height of the dominant stand.

Sample tree volumes were determined by the height accumulation procedure (Grosenbaugh 1954). Volumes per acre for individual plots were determined by applying volume-basal area ratios of the 12-tree sample to plot

basal areas, after the latter were converted to per acre values (Lohrey and Dell 1969). Total and merchantable cubic foot volumes, outside bark, were estimated. Total volumes included all trees 0.6 inch in d.b.h. and larger to a 0-inch top; merchantable volumes included trees 4.6 inches in d.b.h. and larger to a 4.0-inch top.

The growth data presented in this report were adjusted to minimize differences in age of individual plots in an installation in one of two ways: (1) heights in the few plots that were 1 or 2 years younger than others in an installation were adjusted linearly to compensate for age difference; (2) volume and basal area growth are reported as mean annual increment based on the actual age of trees on individual plots when the inventory was made.

Where possible, data for individual installations were evaluated by analyses of variance, with a 0.05 level of significance for differences between species. Mean annual volume increments were also analyzed by covariance; successfully established trees minus those that succumbed later to fusiform rust was a concomitant variable. The purpose of the covariance analyses was to determine differences in yields if the two species had survived equally well. In most cases, results of the variance and covariance analyses agreed; so only results of the analyses of variance are reported.

Heights at age 15 years were related to the soil, geographic, slope, and climatic characteristics of the site by regression analyses. Variables were selected for inclusion in the equation by Grosenbaugh's (1967) system for combinatorial screening of multivariate regressions. Since pairing of species was not required in these analyses and since about one-third of the plots were used to test the accuracy of the equations, the numbers of plots included in individual regressions (Appendix) were different from those listed in table 2.

FIRST-YEAR SURVIVAL

For all installations, first-year survival averaged 77 percent for loblolly pine and 69 percent for slash pine. Differences between species were not significant in about three-fourths of the installations that contained more than one replication of each species (table 3). Slash pine survived better than loblolly in only 1 percent of these installations; loblolly survived

Table 3.—*Performance of loblolly and slash pine on wet, intermediate, and dry sites*

Item	First year survival	Fusiform rust		Height at 15 years	Mean annual increment per acre		
		Stem canker	Mortality		Basal area	Total volume [1]	Merch. volume [2]
	Percent of installations						
Wet sites							
Loblolly sig. better [3]	24	31	19	0	6	0	0
Slash sig. better	0	0	6	57	19	25	31
No sig. diff.	76	69	75	43	75	75	69
Intermediate sites							
Loblolly sig. better	27	31	17	0	20	6	6
Slash sig. better	2	0	0	10	8	11	11
No sig. diff.	71	69	83	90	72	83	83
Dry sites							
Loblolly sig. better	20	71	43	0	0	0	0
Slash sig. better	0	0	0	11	0	14	14
No sig. diff.	80	29	57	89	100	86	86
All sites							
Loblolly sig. better	25	36	20	0	14	3	3
Slash sig. better	1	0	2	24	10	15	17
No sig. diff.	74	64	78	76	76	82	80

[1] Cubic feet (o.b.) in trees $\geq$ 0.6″ d.b.h. to 0″ top.

[2] Cubic feet (o.b.) in trees $\geq$ 4.6″ d.b.h. to 4″ top.

[3] Better means higher first year survival, less fusiform rust infection and mortality, taller, and higher mean annual increment.

better than slash in 25 percent. Included among the latter, however, were 15 installations that were planted with slash pine seedlings from over-dense nursery beds. Loblolly survived better than slash in 88 percent of the plantations where this stock was used. Where other slash pine stock was planted, loblolly survived better in only 7 percent of the wet site installations, 17 percent of intermediate site installations, and 14 percent of dry site installations that could be evaluated statistically; slash pine survived better than loblolly on one intermediate site installation.

Both species survived best on wet and poorest on dry sites (fig. 2). For the two species combined, first-year survival averaged 80 percent on wet sites, 72 percent on intermediate sites, and 54 percent on dry sites.

FUSIFORM RUST

Overall, 31 percent of the slash pines present at age 2 or 3 developed one or more stem infections of fusiform rust by age 15 years, compared to 21 percent for loblolly pines. In none of the 59 installations that supplied statistically analyzable data did significantly fewer slash stems develop cankers than loblolly (table 3). Fewer loblolly than slash pines had cankers in 36 percent of the installations. The trend toward greater stem infection in slash than in loblolly was evident on all sites (fig. 3).

Comparisons within species indicated that seed source influenced rust infection of both species. Georgia slash appeared to be less susceptible than south Mississippi slash to rust invasion of the bole. Similarly, Louisiana loblolly was less susceptible than Mississippi loblolly to the disease. Other studies have shown that host and pathogen have genetic strains that vary in resistance to the disease and in ability to infect the host (Wells and Switzer 1975, Grigsby 1973, Crow 1964, Wells and Wakeley 1966, Snow and others 1975).

Both species were more severely infected on intermediate than on wet or dry sites. This difference arose in part because Louisiana loblolly was planted less frequently on intermediate than on other sites, but other unidentified factors also contributed.

By age 15 years, stem infections were about equally lethal in the two species and had killed about one-third of the trees that developed them. Because slash pine was infected more frequently than loblolly, it sustained higher mortality from the disease (table 3, fig. 3).

HEIGHT

At age 10 years, average heights of dominant and codominant loblolly pines in individual installations ranged from 4 to 40 feet. Slash pine height varied from 10 to 36 feet. The two species differed little in 10-year heights in installations on intermediate and dry sites, but slash tended to be taller than loblolly pine on wet sites (fig. 4). Because 15-year results were

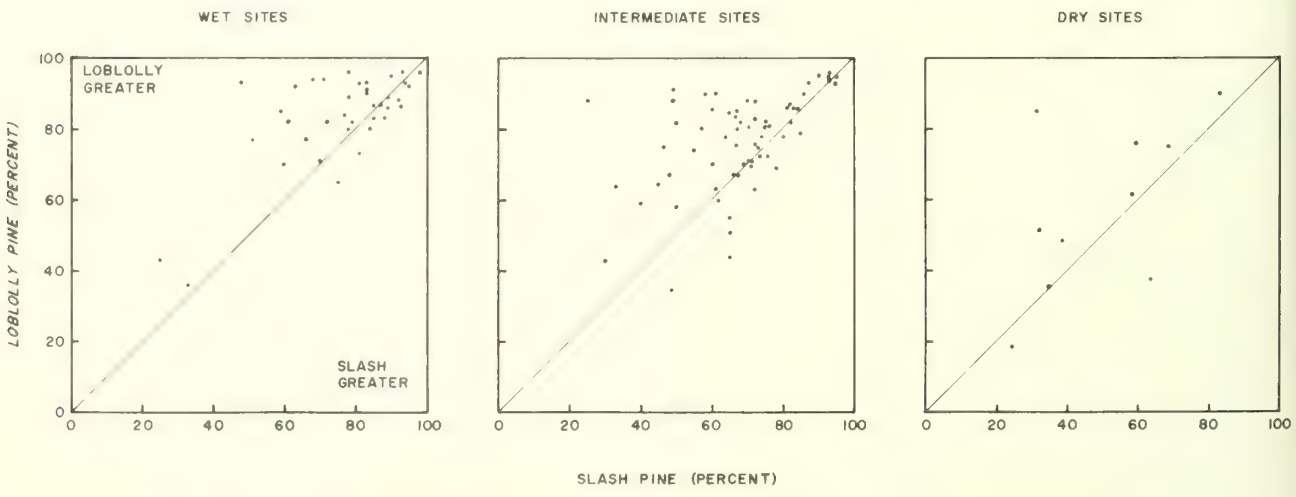

Figure 2.—*First-year survival of loblolly and slash pines. (In this and other figures, diagonal lines represent equal performance by the two species.)*

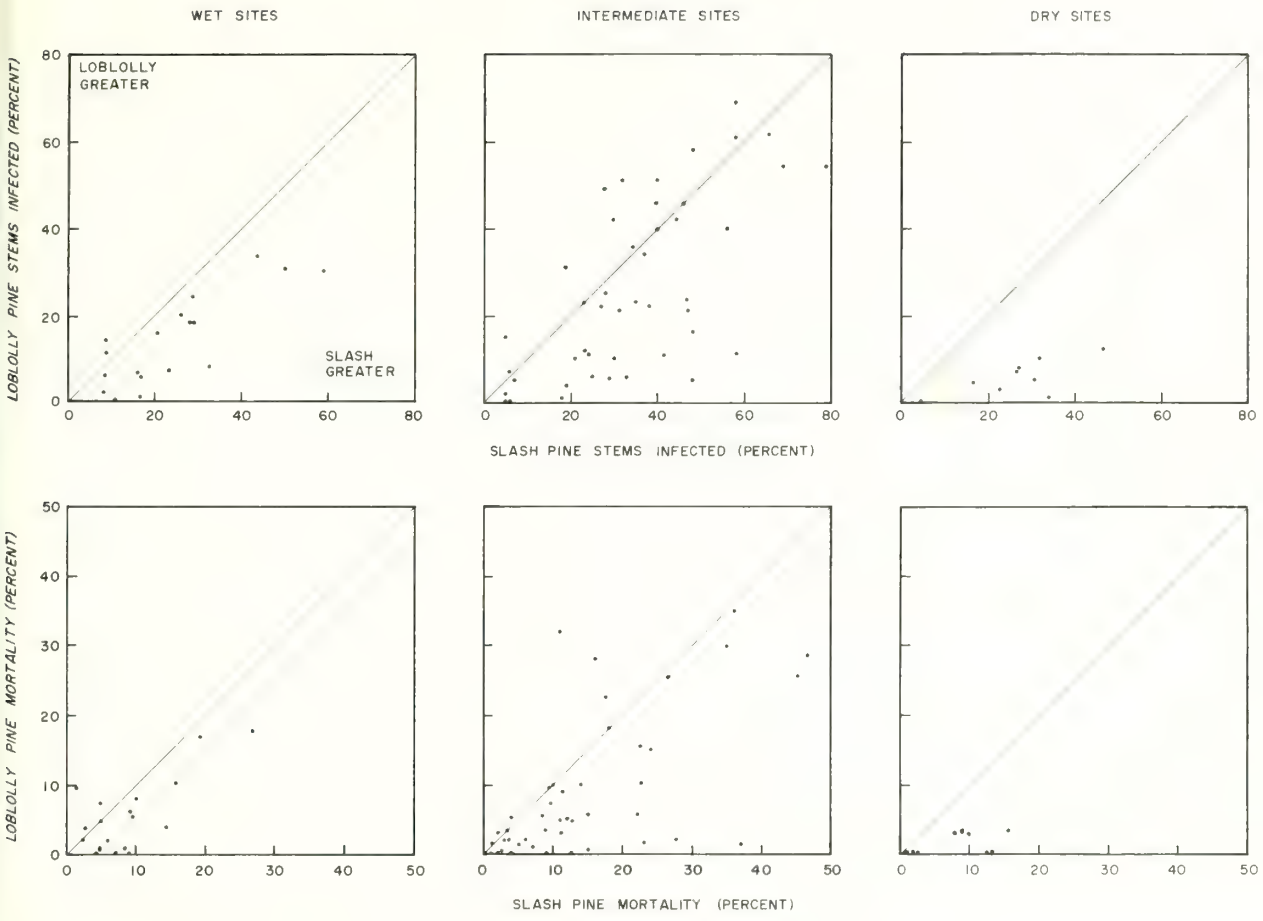

Figure 3.—*Fusiform rust infection and mortality in loblolly and slash pines through age 15 years.*

also available, the 10-year data were not analyzed statistically.

By age 15 years, slash was taller than loblolly pine in 57 percent of the installations on wet sites (table 3). In the remaining 43 percent, the species did not differ significantly in average height of dominant and codominant trees. Overall, slash averaged 35 feet and loblolly 28 feet on wet sites. Slash pine was taller than loblolly in about 10 percent of the installations on intermediate and dry sites. But neither species excelled significantly in height in 90 percent of the installations. Slash and loblolly averaged 40 and 39 feet, respectively, in height on intermediate sites, and 42 and 40 feet on dry sites.

To see how the two species might compare at age 25 years, actual heights of the dominant stand at age 15 years were projected forward 10 years by means of Farrar's (1973) equations for Miscellaneous Publication 50 (USDA 1929) site index curves. (In evaluating the predicted heights, it must be recognized that the values may have been biased somewhat by applying southwide curves to Mississippi and Louisiana sites. The risk seemed worth taking since no local curves were available.)

The projections indicate that slash pine will maintain a 5-foot or greater height advantage over loblolly in 52 percent of the installations on wet sites, and the species will differ less than 5 feet in 44 percent of them. Loblolly is projected to be 5 feet or more taller than slash in 36 percent of the installations on intermediate sites and 5 feet or more shorter than slash on 12 percent. On dry sites, dominant and codominant loblollies are expected to average 5 or more feet taller than slash trees in 20 percent of the installations and to differ from slash by less than 5 feet in 80 percent.

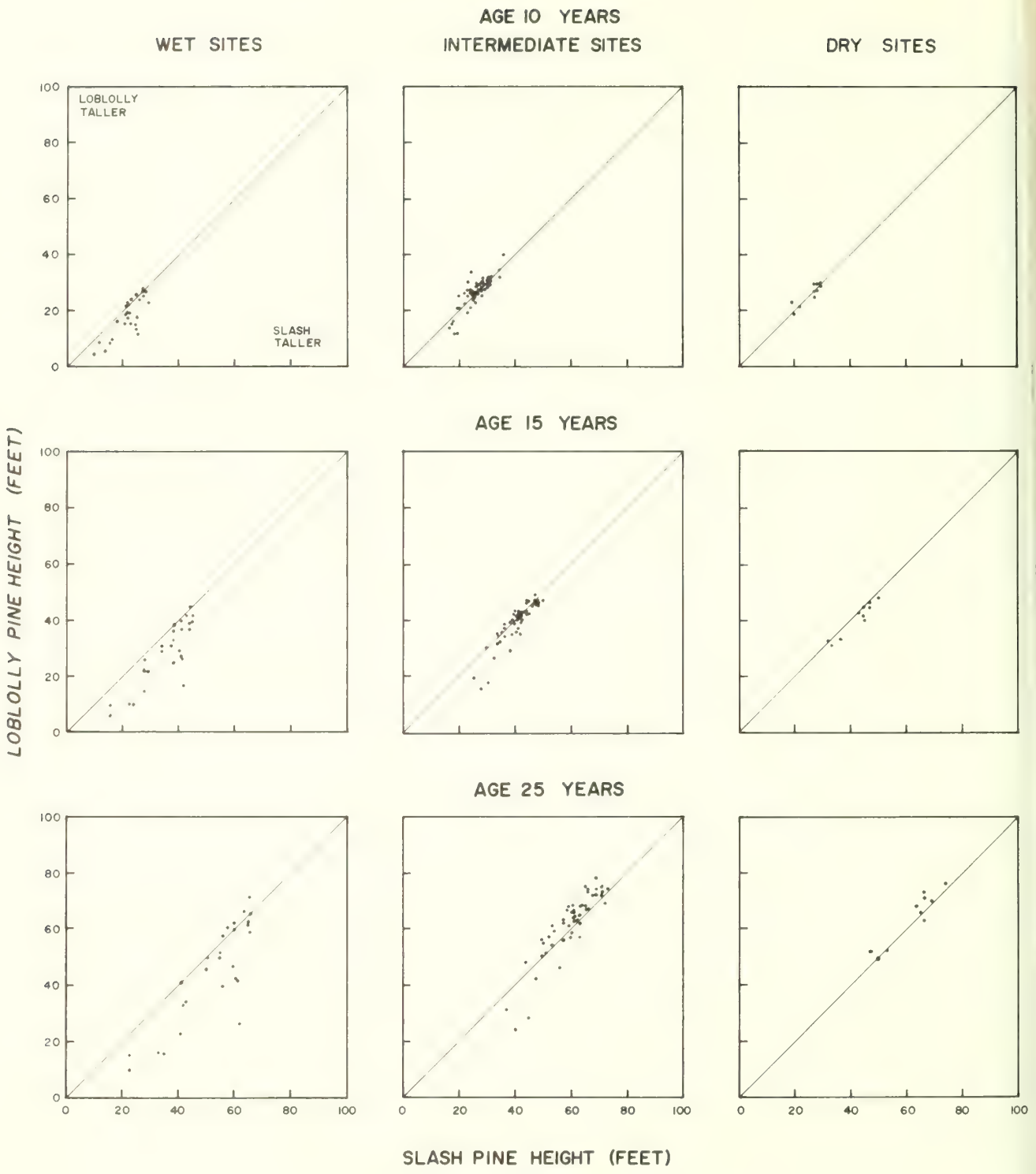

Figure 4.—*Heights of dominant and codominant loblolly and slash pines at various ages.*

MEAN ANNUAL INCREMENT

Basal area.—Mean annual basal area growth of all surviving trees averaged 7.90 ft² per acre for loblolly and 7.62 ft² per acre for slash pine. Moreover, the two species grew in basal area at similar rates in 75 percent of the installations on wet sites, 72 percent of the installations on intermediate sites, and all installations on dry sites for which analyses of variance could be made (table 3).

Species differences in basal area growth varied by site (fig. 5). On wet sites, slash pine basal area increment was greater than loblolly increment in 19 percent of the installations; but on intermediate sites, loblolly excelled in 20 percent of the installations.

Volume.—Species differences in mean annual volume increment were similar whether volumes were computed for trees $\geq$ 0.6 inch in d.b.h. to 0-inch top or for trees $\geq$ 4.6 inches in d.b.h. to a 4.0-inch top (fig. 6). Total volumes averaged about 54 percent greater than merchantable volumes for loblolly and 42 percent greater for slash pine, reflecting greater numbers of trees below 4.6 inches in d.b.h. on loblolly than on slash pine plots. Since trees were planted at a 6- by 6-foot spacing, total mean annual increment to age 15 probably indexes productivity of the sites more precisely than merchantable mean annual increment. For this reason, only total mean annual increments will be discussed.

In 4 of the 16 installations on wet sites that were analyzed for differences in volume, slash grew at a greater annual rate and averaged 122 ft^3 (o.b.) per acre more growth than loblolly each year. Differences between species were not significant in the remaining analyses of wet site installations. Overall, slash averaged 183 ft^3 (o.b.) growth per acre per year and loblolly 138 ft^3.

For intermediate site installations, slash pine volume growth was greater than loblolly in four installations and less than loblolly growth in two installations where analyses were possible. For all installations on intermediate sites, total mean annual increment averaged 177 ft^3 per acre for loblolly and 165 ft^3 per acre for slash.

The seven analyses of dry site data produced only one significant difference between species in total mean annual increment. In that installation slash pine excelled. Volume growth was surprisingly good on dry sites: loblolly averaged 197 ft^3 and slash averaged 205 ft^3 (o.b.) per acre per year in trees 0.6 inch in d.b.h. and larger. Possibly, the young stands had not yet suffered unduly from these soils' limited capacity to supply moisture.

RELATIONSHIP BETWEEN HEIGHTS AND SITE CHARACTERISTICS

Regression analyses were made to further define the characteristics of wet, intermediate, and dry sites that were associated with heights of the dominant stands at age 15 years. Features of these sites included in the analyses are listed in table 1. Squared and cubed powers of many of these characteristics were also screened by Grosenbaugh's (1967) REX procedure for inclusion in the "best-fit" solution. Actual regression equations, numbers of plots in each regression, and goodness of fit statistics are given in the Appendix.

Wet sites.—The "best-fit" equations for both species indicate that average heights of dominant and codominant trees declined as average growing season rainfall increased. Jackson (1962) reported a similar response of slash pine to growing season rainfall (March

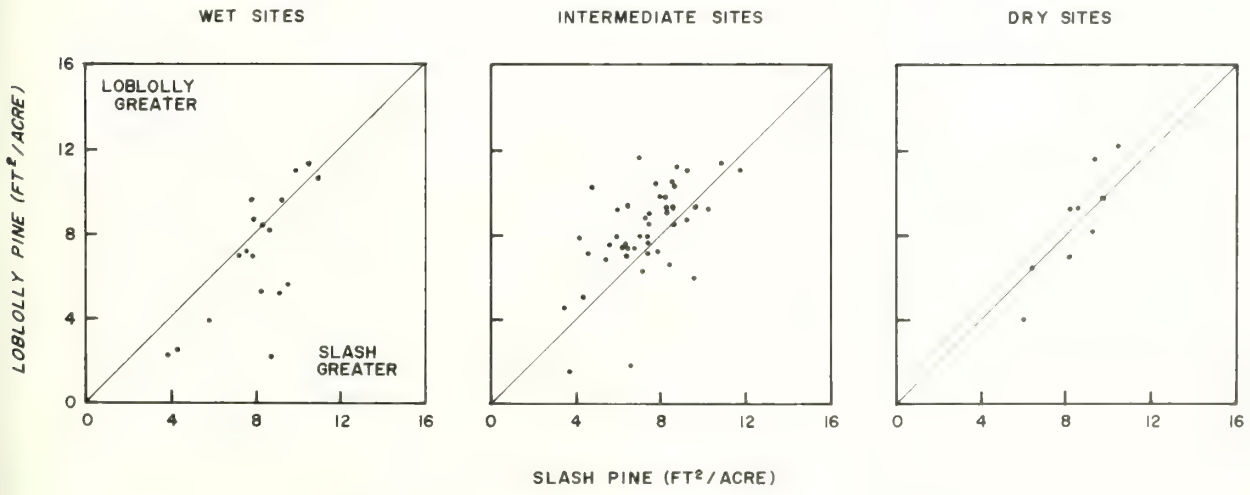

Figure 5.—*Mean annual basal area increment, all trees.*

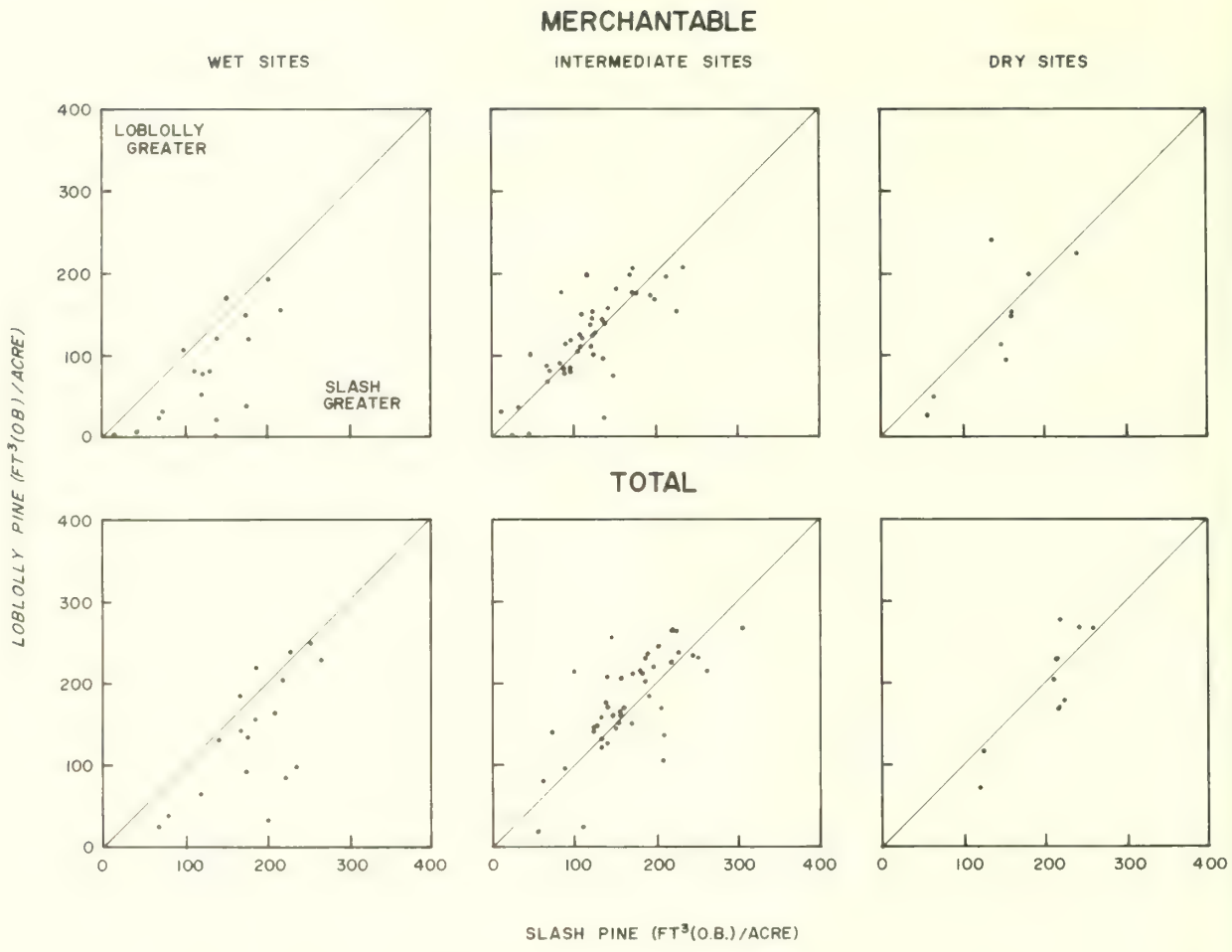

Figure 6.—*Mean annual cubic-foot increment of loblolly and slash pine to age 15 years in trees $\geq$ 0.6 inch in d.b.h. to 0-inch top (total) and in trees $\geq$ 4.6 inches in d.b.h. to 4.0-inch top (merchantable).*

through August in his study) in regions where annual rainfall was 50 inches or more and attributed it to the depressive effects of reduced soil aeration during the period of most active height growth. Probably the relationship is more complex than Jackson indicated, and additional research is needed to isolate all factors involved. In the present experiment, average annual rainfall was the first factor to enter "best-fit" regressions. It accounted for 62 percent of the variation in slash and 57 percent of the variation in loblolly pine heights at age 15 years.

A slope of about 0.5 percent was optimum for growth of both species, and heights declined as slope became greater or less. Zahner (1958) reported a similar relationship between slope and site index of loblolly pine on azonal soils.

Heights also varied directly with percent organic matter in the A_1 horizon. Probably organic matter improved soil structure and soil aeration.

Clay content of the 6-10 inch layer and its square were the only textural variables in the "best-fit" slash regression. In the absence of other variables, clay in this layer was positively correlated with height. In the presence of other variables in the equation, the slope of the line was negative when clay comprised less than 19 percent of the soil particles and positive when it comprised more. The reason the relationship changed when other variables were included is unclear. In any case, texture affected height less than other factors in solutions of the equations for representative soil textures and site conditions (table 4).

The regression for loblolly pine indicated that its heights were greater if the 6-10 inch layer was loam than if it was heavier or lighter, and if the 16-20 inch layer contained

Table 4.—*Estimated heights of dominant and codominant trees at age 15 years on wet sites*

Average growing season rainfall	Organic matter in A-horizon	Slope	Texture of 6-10 inch layer	Loblolly pine on soil having in 16-20 inch layer		Slash pine
				20% sand	45% sand	
Inches	*– – Percent – –*			*– – – – – – – Feet – – – – – – –*		
28	0.5	0	Sandy loam [1]	24.9	28.6	34.3
			Loam [2]	27.9	31.5	30.5
			Silt loam [3]	27.2		31.1
		1	Sandy loam	27.5	31.1	40.4
			Loam	30.5	34.1	36.6
			Silt loam	29.8		37.2
		3	Sandy loam	23.4	27.1	37.8
			Loam	26.4	30.1	34.0
			Silt loam	25.7		34.6
	2.5	0	Sandy loam	37.0	40.7	44.0
			Loam	40.0	43.6	40.2
			Silt loam	39.3		40.8
		1	Sandy loam	39.6	43.2	50.1
			Loam	42.5	46.2	46.3
			Silt loam	41.9		46.9
		3	Sandy loam	35.5	39.2	47.5
			Loam	38.5	42.2	43.8
			Silt loam	37.8		44.4
38	0.5	0	Sandy loam	9.5	13.2	20.7
			Loam	12.5	16.2	16.9
			Silt loam	11.8		17.5
		1	Sandy loam	12.1	15.8	26.8
			Loam	15.1	18.7	23.0
			Silt loam	14.4		23.6
		3	Sandy loam	8.0	11.7	24.2
			Loam	11.0	14.7	20.4
			Silt loam	10.4		21.0
	2.5	0	Sandy loam	21.6	25.3	30.4
			Loam	24.6	28.3	26.6
			Silt loam	23.9		27.2
		1	Sandy loam	24.2	27.8	36.5
			Loam	27.2	30.8	32.7
			Silt loam	26.5		33.3
		3	Sandy loam	20.1	23.8	33.9
			Loam	23.1	26.8	30.1
			Silt loam	22.4		30.8

[1] 65% sand, 25% silt, 10% clay
[2] 40% sand, 40% silt, 20% clay
[3] 20% sand, 65% silt, 15% clay

45 percent sand than if it contained more or less. Probably wet site soils containing less than 45 percent sand in the 16-20 inch layer are too poorly aerated for maximum loblolly pine development, and those that contain more store insufficient available moisture.

The regressions predicted similar 15-year heights for slash and loblolly pines on level to slightly sloping wet sites having about 40 percent sand, 40 percent silt, and 20 percent clay in the 6-10 inch layer and 45 percent sand in the 16-20 inch layer of soil. For other combinations of rainfall, slope, and soil texture representative of the wet sites, the regressions predicted greater heights for slash than for loblolly pine.

The slash pine equation accounted for 75 percent of the variation in 15-year heights of dominant and codominant trees on wet sites and predicted 69 percent of the heights on which it was based within ± 5 feet (table 5). In an independently drawn sample of 29 obser-

Table 5.—*Departures of observed from predicted heights in regression analyses*

Species site and sample	Differences between observed and predicted values of no more than—					
	± 2 feet	± 5 feet	± 10 feet	± 2 feet	± 5 feet	± 10 feet
	– – *Number of observations* – –			– – *Percent of observations* – –		
Observations included in regression solution						
Loblolly pine						
Wet sites	15	30	47	32	64	100
Intermediate sites	28	60	87	29	62	90
Dry sites	15	26	27	56	96	100
Slash pine						
Wet sites	11	36	50	21	69	96
Intermediate sites	29	64	91	32	70	99
Dry sites	8	24	27	30	89	100
Additional independent observations						
Loblolly pine						
Wet sites	4	14	21	16	56	84
Intermediate sites	13	29	44	29	63	96
Slash pine						
Wet sites	9	15	27	31	52	93
Intermediate sites	14	28	42	32	64	95

vations, it predicted 52 percent within ± 5 feet. The loblolly pine regression explained 80 percent of the variation in loblolly pine heights and predicted 64 percent of the values on which it was based within ± 5 feet. It predicted 56 percent of an independent set of 25 observations within ± 5 feet.

Intermediate sites.—Both slash and loblolly pine regressions indicated that heights declined as growing season rainfall increased and that trees were taller on slightly sloping than on essentially level sites. A slope of about 4 percent was optimum for slash pine. The loblolly pine curve did not culminate, but slopes greater than 2 percent had little impact on predicted heights. Zahner (1958) reported a simple negative relationship between slope and loblolly pine site index for zonal soils. He also reported that thickness of the A horizon influenced site index of zonal soils. The latter variable did not appear in the "best-fit" regression in the present study.

Within the range of textures encountered in the study, the equations predicted slightly greater heights for both slash and loblolly pine if the B horizon was loam than if it was silt or clay (table 6). These results agree in general with Zahner's (1958) findings for zonal soils.

Solutions of the intermediate site equations for representative rainfalls, slopes, and soil textures usually showed height differences of 5 feet or less between the two species on similar sites. They indicated, however, a height advantage of more than 5 feet for slash pine in regions of high average growing season rainfall on soils having silt loam B horizons.

The slash pine regression accounted for 42 percent of the variation in height of the dominant stand and predicted 70 percent of the heights on which it was based within ± 5 feet. It predicted 64 percent of an independent set of 44 observations within ± 5 feet. The loblolly pine regression accounted for 43 percent of the variation in height and fit the data about as well as the slash pine regression (table 5).

Dry sites.—Fewer observations were available to develop relationships between heights and site characteristics for dry than for intermediate and wet sites. Therefore, only linear expressions of soil textures and available soil moisture were fitted, and no data were reserved to test the regression.

Table 6.—*Estimated heights of dominant and codominant trees at age 15 years on intermediate sites*

Slope	Texture of B horizon	Average growing season rainfall of 28 inches		Average growing season rainfall of 38 inches	
		Loblolly pine	Slash pine	Loblolly pine	Slash pine
Percent		*Feet*			
1	Silt loam [1]	36.3	39.7	28.1	33.0
	Loam [2]	39.1	40.0	30.9	33.3
	Clay loam [3]	37.5	36.7	29.3	30.0
	Clay [4]	36.8	34.7	28.6	28.0
3	Silt loam	39.3	44.3	31.1	37.6
	Loam	42.0	44.6	33.8	37.9
	Clay loam	40.4	41.3	32.2	34.6
	Clay	39.7	39.3	31.5	32.6
5	Silt loam	39.9	44.4	31.7	37.7
	Loam	42.6	44.7	34.4	38.0
	Clay loam	41.0	41.4	32.8	34.7
	Clay	40.3	39.4	32.1	32.7
7	Silt loam	40.1	43.9	31.9	37.2
	Loam	42.8	44.2	34.7	37.5
	Clay loam	41.3	40.9	33.1	34.2
	Clay	40.6	38.8	32.4	32.1

[1] 20% sand, 65% silt, 15% clay.
[2] 40% sand, 40% silt, 20% clay.
[3] 30% sand, 35% silt, 35% clay.
[4] 25% sand, 25% silt, 50% clay.

Heights of both loblolly and slash pines varied directly with average annual rainfall, probably because the sandy soils were unable to store sufficient moisture for optimum growth. Heights increased with slope to 2.8 percent and declined thereafter. Relationships between heights and soil texture showed that slash pine heights increased with increasing silt in the 16-20 inch layer and loblolly heights increased with increasing clay in the 36-42 inch layer. Clearly, both species responded positively to additional capacity of the subsoil to retain available moisture. The loblolly pine equation, however, showed that heights decreased with increasing silt in the 6-10 inch layer. The apparent paradox may indicate that pines on these droughty sites compete unfavorably with other vegetation and evaporation for moisture from light summer showers that is retained near the soil surface.

Solutions of the equations for representative rainfalls, slopes, and soil textures (table 7) indicated that slash pine outgrew loblolly in lower rainfall areas on steeper slopes; that loblolly outgrew slash pine in higher rainfall

Table 7.—*Estimated heights of dominant and codominant trees at age 15 years on dry sites*

Average annual rainfall	Slope	Subsoil texture [1]	Loblolly pine on soil having 6-10 inch layer of—		Slash pine
			Sand	Loamy sand	
Inches	*Pct.*		*Feet*		
46	2	Sand [2]	29.0		29.2
		Loamy sand [3]	29.5	28.1	30.7
		Sandy loam [4]	30.8	29.4	32.2
	5	Sand	24.3		28.6
		Loamy sand	24.7	23.4	30.1
		Sandy loam	26.1	24.7	31.7
56	2	Sand	48.4		42.9
		Loamy sand	48.8	47.5	44.4
		Sandy loam	50.2	48.8	46.0
	5	Sand	43.7		42.3
		Loamy sand	44.1	42.7	43.7
		Sandy loam	45.4	44.0	45.4

[1] 16-20 inch layer for slash and 36-42 inch layer for loblolly pine.
[2] 92% sand, 5% silt, and 3% clay.
[3] 84% sand, 10% silt, and 6% clay.
[4] 70% sand, 15% silt, and 15% clay.

areas on gentler slopes; and that height growth of both species was curtailed by rainfalls, slopes, and soil textures which reduced the amount of moisture available to tree roots.

The slash pine regression accounted for 72 percent of the variations in heights and predicted 96 percent of the values on which it was based within ± 5 feet (table 5). The loblolly pine equation explained 82 percent of the variation and predicted 89 percent of the observations within ± 5 feet.

DISCUSSION AND CONCLUSIONS

Results of this study suggest that, as a species, loblolly may have a slightly higher potential to survive outplanting than slash pine, especially on moderately well to excessively drained soils. This advantage is easily overcome by planting about 10 percent more slash than loblolly pine seedlings per acre. Similarly, the tendency of more slash pine stems to develop infections of fusiform rust can be overcome by planting more trees or planting rust resistant trees that otherwise perform at least as well as trees from local seed.

In volume and height through age 15 years, slash has grown as well as or better than loblolly pine on level or nearly level sites having imperfectly or less well drained silt loam soils, especially in areas of relatively high growing season rainfall. In most other situations the two species have usually grown equally well. Here too, however, slash has outperformed loblolly in a small proportion of the outplantings.

If the 10-year projected heights are reliable indicators of the species performance to age 25 years, then slash pine probably will maintain its advantage over loblolly on flat, wet sites. But loblolly should equal or surpass slash in growth and yield on intermediate and dry sites.

Relationships between heights and rainfall, slope, organic matter, and soil texture are about the same as have been reported (Coile 1952, 1959, Jackson 1962, Zahner 1958) if composite rather than individual effects of sand, silt, and clay on heights are considered. These site characteristics collectively accounted for 42 to 82 percent of the variation in height in individual regressions.

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APPENDIX

REGRESSIONS HAVING SMALLEST RATIOS OF MEAN SQUARED RESIDUALS

Wet Sites

$$Y_L = 138.8 - 1.54(X_2) - 2.19(X_3) - 0.524(1/X_3) + 6.05(X_4) - 0.400(X_5) - 3.53(X_6) + 0.0745(X_6^2) - 0.00055(X_6^3) + 0.517(X_8) - 0.00572(X_8^2)$$

N = 47 RMSQR = 0.2556

S. E. of Est. = 5.71 $R^2 = 0.80$

$$Y_S = 92.5 - 1.36(X_2) - 1.537(X_3) - 0.839(1/X_3) + 4.87(X_4) - 1.92(X_7) + 0.0514(X_7^2)$$

N = 52 RMSQR = 0.2842

S. E. of Est. = 5.37 $R^2 = 0.75$

Intermediate Sites

$$Y_L = 66.4 - 0.821(X_2) - 4.40(1/X_3) - 0.388(X_8) + 0.0158(X_8^2) - 0.00015(X_8^3)$$

N = 97 RMSQR = 0.6041

S. E. of Est. = 6.17 $R^2 = 0.43$

$$Y_S = 78.0 - 0.671(X_2) - 0.512(X_3) - 8.45(1/X_3) - 0.861(X_8) + 0.0245(X_8^2) - 0.0002(X_8^3) - 0.073(X_{10}) - 0.00255(X_{10}^2) + 0.00003(X_{10}^3)$$

N = 92 RMSQR = 0.6460

S. E. of Est. = 4.77 $R^2 = 0.42$

Dry Sites

$$Y_L = 36.0 + 1.94(X_1) - 22.1(X_3) + 1.33(X_3^2) - 112.1(1/X_3) - 0.281(X_6) + 0.147(X_{11})$$

N = 27 RMSQR = 0.2340

S. E. of Est. = 3.00 $R^2 = 0.82$

$$Y_S = 50.0 + 1.37(X_1) - 18.6(X_3) + 1.13(X_3^2) - 105.3(1/X_3) + 0.305(X_9)$$

N = 27 RMSQR = 0.3456

S. E. of Est. = 3.83 $R^2 = 0.72$

Where Y_L = Average 15-year height of dominant and codominant loblolly pines

Y_S = Average 15-year height of dominant and codominant slash pines

and X_1 = Average annual rainfall for installation

X_2 = Average growing season rainfall for installation

X_3 = Percent slope + 0.1

X_4 = Percent organic matter in A_1 horizon

X_5 = Percent sand in 6-10 inch layer (Wet and Dry sites) or A_2 horizon (Intermediate sites)

X_6 = Percent silt in 6-10 inch layer (Wet and Dry sites) or A_2 horizon (Intermediate sites)

X_7 = Percent clay in 6-10 inch layer (Wet and Dry sites) or A_2 horizon (Intermediate sites)

X_8 = Percent sand in 16-20 inch layer (Wet and Dry sites) or B_2 horizon (Intermediate sites)

X_9 = Percent silt in 16-20 inch layer (Wet and Dry sites) or B_2 horizon (Intermediate sites)

X_{10} = Percent clay in 16-20 inch layer (Wet and Dry sites) or B_2 horizon (Intermediate sites)

X_{11} = Percent clay in 36-42 inch layer (Dry sites only)

Shoulders, Eugene

1976. Site characteristics influence relative performance of loblolly and slash pine. South. For. Exp. Stn., New Orleans, La. 16 p. (USDA For. Serv. Res. Pap. SO-115)

Through age 15 years, slash pine outperformed loblolly on flat, wet sites, but the two species grew about equally well in most other situations. On intermediate and dry sites, loblolly is expected to equal or surpass slash pine in growth and yield by age 25 years.

ADDITIONAL KEYWORDS: *Pinus elliottii, Pinus taeda,* soil-site relationships, survival, height growth, volume increment, fusiform rust infection.

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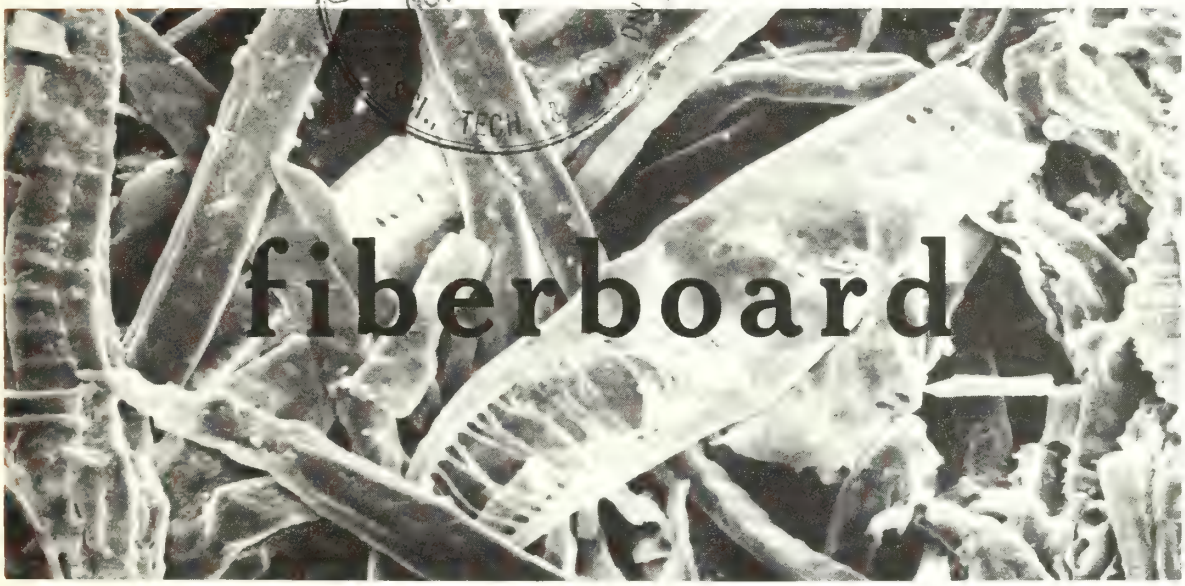
properties of medium-density fiberboard produced in an oil-heated laboratory press



Otto Suchsland and George E. Woodson

Southern Forest Experiment Station
Forest Service
U. S. Department of Agriculture

1976

Properties of Medium-Density Fiberboard Produced in an Oil-Heated Laboratory Press

Otto Suchsland
and
George E. Woodson

Medium-density fiberboards from pressurized double-disk refined fibers have a close correlation between layer density and layer dynamic modulus of elasticity. Density distribution over the thickness was readily controlled by manipulating platen temperature and applied pressure. Thus, overall modulus of elasticity could be adjusted. In contrast to modulus of elasticity, internal bond was sensitive to resin level and resin distribution. Milling the fibers after blending with 8, 10, and 12 percent resin solids increased internal bond strengths by 73, 71, and 82 percent, respectively. Fiberboards from mixed hardwoods produced commercially in a high frequency press had dense face layers (0.98 g/cc) and less dense cores (0.60 g/cc); such density profiles could be duplicated with sweetgum fibers pressed at 335°F and 480 to 820 psi in a conventionally heated press. Linear expansion of the commercial boards was higher and thickness swell lower than that of laboratory hot-pressed sweetgum boards. At equal densities, dynamic modulus of elasticity was lower in the commercial boards than in the sweetgum boards.

ADDITIONAL KEYWORDS: Density profiles, modulus of elasticity, platen temperature, internal bond, resin level, resin distribution, *Liquidambar styraciflua*, linear expansion, thickness swell.

Medium-density fiberboard (MDF) is utilized in manufacture of furniture, cabinets, and core stock under fine veneers and other surface finishes. It is produced by reducing raw material to fibers in pressurized disk refiners; these fibers are then bonded together with low viscosity, low tack, synthetic resins and formed into mats. The process offers an opportunity for profitably utilizing wood once considered waste because it tolerates wide variation in raw material such as species composition, geometric configuration, and bark inclusion.

Commercially produced MDF has better machining characteristics than conventional particleboard, good screw-holding power, and high internal bond strength. These features are in part attributed to the use of high frequency energy to cure the resin in the press (Raddin 1967). In conventional pressing, severe density contrasts (face to core) are produced at high temperatures and high pressures, and are caused by the temperature gradients occurring in the mat during the initial phase of the press cycle (Strickler 1959, Suchsland 1967). It is claimed that high frequency moderates this density contrast (Anon. 1974). On the other hand, high frequency curing requires higher initial investment and results in higher operating costs (Vajda 1970).

The primary objective of this study was to investigate the possibilities of producing high quality medium-density fiberboard without the use of high frequency energy. Preliminary results were presented earlier (Suchsland and Woodson 1975).

PROCEDURE

Material Collection and Preparation

Thirteen sweetgum (*Liquidambar styraciflua* L.) trees were felled, hand-peeled, and chipped at a local sawmill. Trees averaged 8.4 inches in

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d.b.h. and 52.4 feet in total height. All material to a 4-inch top diameter was utilized. Average specific gravity of disks removed at breast height was 0.51 (based on ovendry weight and green volume).

Green chips were transported to the Bauer Bros. Company laboratory in Springfield, Ohio, for refining in a Bauer 418 pressurized refiner.[1] Refiner conditions were held constant at dwell time of 5 minutes, steam pressure of 100 psi, plate clearance of 0.050 inch, and feed rate of 4.53 ovendry tons per day. Green chips entered the refiner at a density of 21.7 lb ft^3 and 109 percent moisture content. Wet fibers emerged at a density of 4.3 lb ft^3 and 130 percent moisture content.

Fibers were dried in a small rotating drum capable of drying about 100 pounds of wet fibers per load. Hot air (about 240 F) was introduced through the tumbling fibers from the center; wet fibers were dried to less than 5 percent moisture content in 3½ hours.

The distribution of fiber lengths was measured on a Bauer-McNett model 203-A classifier:

Mesh[2]	Percent
−8	33.8
−8/+14	17.5
−14/+28	21.8
−28/+48	13.0
−48/+100	2.4
−100	11.5

Fiber Blending and Mat Formation

Fibers were tumbled in a rotating wooden drum while a center-mounted spray gun dispersed a resin and wax mixture. Resin level was 8 percent (Allied Chemical Fiberbond binder); wax solids equalled 1 percent (Hercules Inc., Paracol 404N).

Treated fibers were brushed through ¾-inch hardware cloth mounted on top of a forming box. Final mat size was 18 by 20 inches and about 13 inches thick for a ¾-inch board at a density of 45 lb/ft^3; mats for ⅜-inch boards were half as thick. Mat moisture content was about 12 percent.

[1] Mention of trade names is solely to identify material and equipment used and does not imply endorsement by the U. S. Department of Agriculture.

[2] Tyler standard sieves; minus indicates passing a given screen; plus indicates retained by a given screen.

A supplementary study was designed to investigate the effect of resin level (8, 10, or 12 percent) and resin distribution. Fibers were run through a Sprout Waldron 12-inch single-disk refiner equipped with spike-tooth disk sections either before (b) or before and after (b & a) the blending operation (fig. 1A). The plate clearance was adjusted so that fiber characteristics remained unchanged and fiber clumps formed in the blender were dispersed. Mats were formed on an improved, time-saving

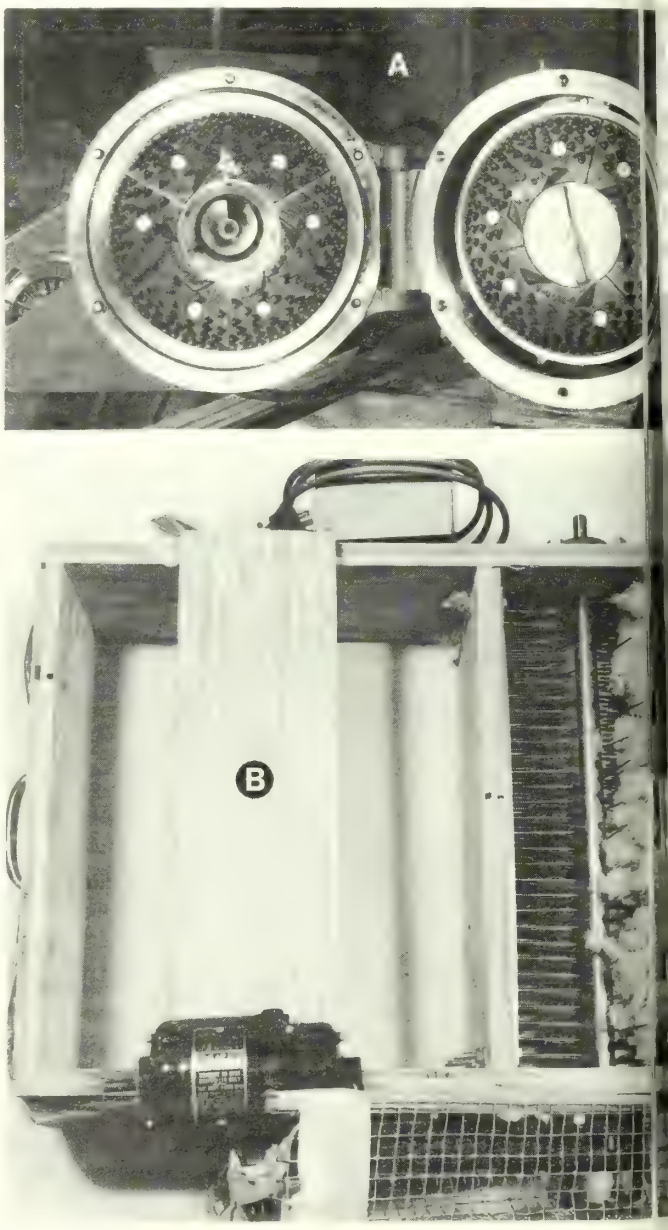


Figure 1.—*In the supplementary experiment, fibers were fluffed in a Sprout-Waldron refiner (A), then run through a mechanized forming device (B).*

device, employing a set of engaging spikes which evenly distributed the fibers in a forming box beneath (fig. 1B).

Board Manufacture

In the main experiment (table 1), we varied prepress pressure, hot-press pressure, and platen temperature to try to reduce closing time and thus moderate density contrast. All mats were prepressed at room temperature in a Riehle testing machine. Series A, B, and C were pressed at 60 psi. To obtain pressure of 650 psi, it was necessary to rip mats into 9- by 20-inch halves and press each half individually (Series D, E, F). Several of these half-mats were separated into face and core layers (50 percent in core and 25 percent in each face); the layers were prepressed at 60 psi or 650 psi and reassembled before hot-pressing (fig. 2). This high compression combined with high laminating pressure of 1,500 psi was intended to approach a uniform density condition.

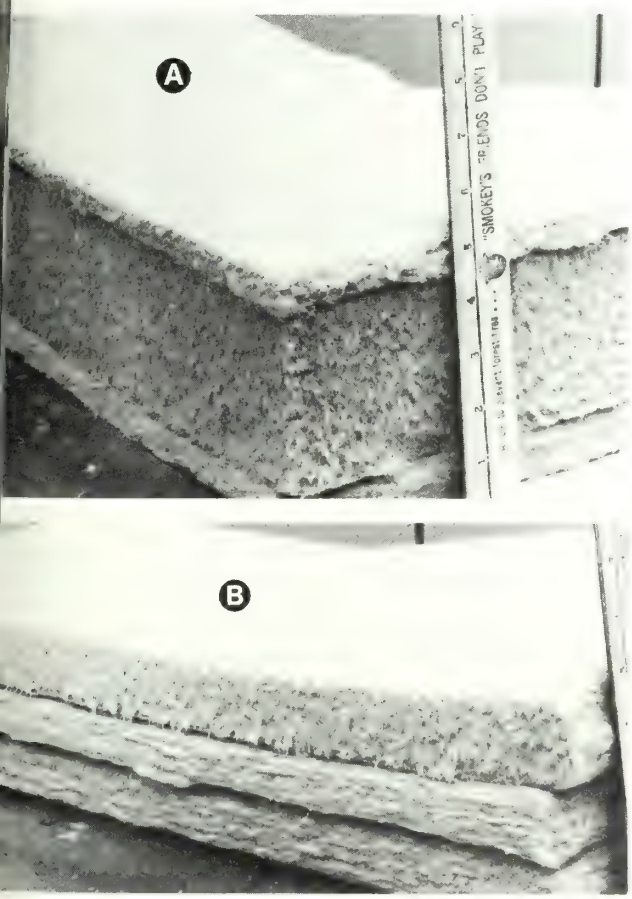


Figure 2.—*Mats for three-layer boards: (A) series E—face prepressed at 650 psi and core prepressed at 60 psi for 2 minutes, (B) series F—face prepressed at 60 psi and core prepressed at 650 psi for 2 minutes.*

Preliminary tests showed that the following curing times in the hot-press were adequate for the corresponding platen temperatures and board thicknesses:

Platen temperature	Board thickness	Total press time
°F	*Inch*	*Min*
335	3/4	9
	3/8	6
250	3/4	12
	3/8	8

Thickness stops controlled board thickness. Closing time was controlled indirectly by the magnitude of the applied pressure.

Series G boards were a special effort to eliminate density contrast entirely. Mats were compressed to final thickness (3/4 inch) in the unheated hot-press before applying heat. Temperature was increased from 70 °F to 285 F over a period of 1 1/4 hours. During this period of time and before any resin curing had taken place, the mat had lost essentially all resistance to compression and therefore was not trying to spring back to its original shape.

In the supplementary experiment (table 2), all mats were prepressed at 60 psi and hot-pressed at 820 psi. Platen temperatures were 250 and 335 °F, and closing time ranged from 8 to 10 seconds.

Determination of Board Properties

Two strips 1 1/8 by 18 inches were ripped from the center of each board, weighed, and measured for density calculations.

The resonance frequency, i.e., frequency at which maximum vibrations existed (Bair 1964), was measured on an oscilloscope and used to calculate the dynamic modulus of elasticity (E) as follows:

$$E = \frac{fr^2 l^3 w (5.4 \times 10^{-6})}{h^3 b}$$

where:

E = effective dynamic modulus of elasticity, psi

fr = resonance frequency

l = length, in

Table 1.—*Design of experiment and summary of results from boards made under different press schedules and with 8 percent resin content*

Furnish	Sweetgum																					Mixed hardwoods
Series	A				B				C				D				E		F		G	H
Pressure—psi	240				480				820				1,500				1,500		1,500		820 → 480	
Prepressure—psi	60				60				60				650				Face: 650 Core: 60		Face: 60 Core: 650		—	Commercial board
Platen temperature, °F	250		335		250		335		250		335		250		335		250	335	250	335	70 → 285	
Board thickness, in	3/4	3/8	3/4	3/8	3/4	3/8	3/4	3/8	3/4	3/8	3/4	3/8	3/4	3/8	3/4	3/8	3/4	3/4	3/4	3/4	3/4	3/4
Group number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Replications	3	3	3	3	3	3	3	3	3	3	3	3	6	6	6	6	4	4	4	4	2	
Closing time, seconds	299	109	128	49	57	24	32	11	9	6	10	7	2	2	2	2	5	5	4	5		
Density—g/cm³	.713	.773	.718	.757	.733	.791	.732	.786	.742	.798	.745	.798	.736	.743	.724	.739	.751	.755	.760	.758	.736	.721
Modulus of elast., 1,000 psi	423	476	517	571	517	575	633	717	504	623	645	764	506	538	578	610	569	663	585	653	469	531
Internal bond—psi	44.1	53.7	30.6	50.3	35.0	52.7	30.7	52.4	41.4	61.0	40.3	71.6	39.0	45.3	43.7	46.4	43.0	46.5	40.0	38.9	54.2	111.3

Table 2.—*Summary of results for supplemental study using sweetgum fibers prepressed at 60 psi and hot-pressed at 820 psi (closing time 8-10 seconds)*

Platen temperature °F	250												335					
Board thickness, in	3/8						3/4						3/8					
Resin content, percent	8		10		12		8		10		12		8		10		12	
Milled	b	b & a	b	b & a	b	b & a	b	b & a	b	b & a	b	b & a	b	b & a	b	b & a	b	b & a
Density—g/cm³	.714	.652	.766	.727	.798	.765	.680	.692	.706	.709	.746	.720	.686	.664	.757	.731	.775	.756
Modulus of elast., 1,000 psi	494	424	569	545	639	591	471	499	514	529	620	544	529	514	760	627	744	649
Internal bond—psi	34.7	48.4	58.1	108.1	72.1	106.2	33.3	71.4	56.9	95.8	54.0	131.3	23.8	38.5	57.3	90.7	65.6	111.1

w = weight, g

h = thickness, in

b = width, in

Density profiles and E profiles through board thickness were also determined. In a given pair of matched strips, material was planed from the top surface of one and bottom surface of the other. These pieces were then laminated together with the planed surfaces as the contact area. Since the planer was preset to a desired thickness, initial thickness of all laminated specimens was constant, and thin layers of uniform thickness could be removed; material was removed until half the original board thickness had been planed off each side. Density of each layer was calculated and the dynamic modulus of elasticity of each layer (E_L) was determined by measuring the effective E before and after planing as follows:

$$E_L = \frac{E_1 - E_2 \left[\frac{h_2}{h_1}\right]^3}{1 - \left[\frac{h_2}{h_1}\right]^3}$$

where:

E_L = dynamic modulus of elasticity of layer removed, psi

E_1 = E before planing, psi

E_2 = E after planing, psi

h_1 = thickness before planing, in

h_2 = thickness after planing, in

Equilibrium moisture content and thickness swelling were determined on small blocks measuring ¾- by ¾-inch by board thickness. Blocks were equilibrated in six dessicators containing salt solutions ranging from 0 percent to 93 percent relative humidity (RH).

Linear expansion was determined on 12-inch long specimens by means of a optical comparator described by Suchsland (1970). Exposure conditions were 48 percent and 90 percent relative humidity at 70°F.

Internal bond tests were done in accordance with ASTM specifications D-1037-64.

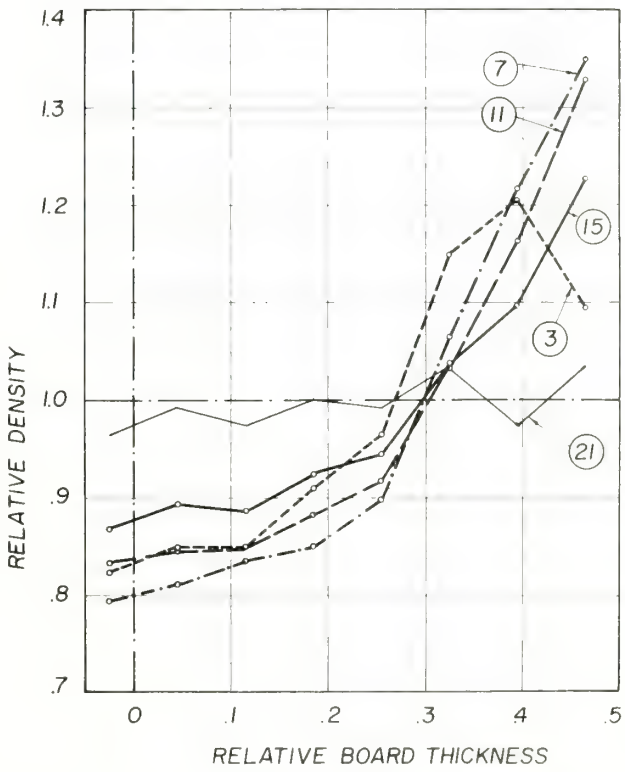
Properties of ¾-inch experimental boards were compared with those of commercial boards made from mixed hardwoods and cured with high frequency energy.

RESULTS AND DISCUSSION

Density Distribution

Relative density profiles (layer density divided by average density) of typical ¾-inch boards are shown in figures 3 and 4.

Boards made by pressing the mat to stops in an unheated press (Series G) had nearly uniform density throughout the thickness (fig. 3). Those pressed at 335°F and at 480 or 820 psi had face densities more than 30 percent higher than the average density; density contrast was somewhat less in boards prepressed at 650 psi and hot-pressed at 1,500 psi. In boards pressed at 240 psi, maximum density occurred beneath the face, resulting in a sinusoidal density profile. Profiles for ⅜-inch

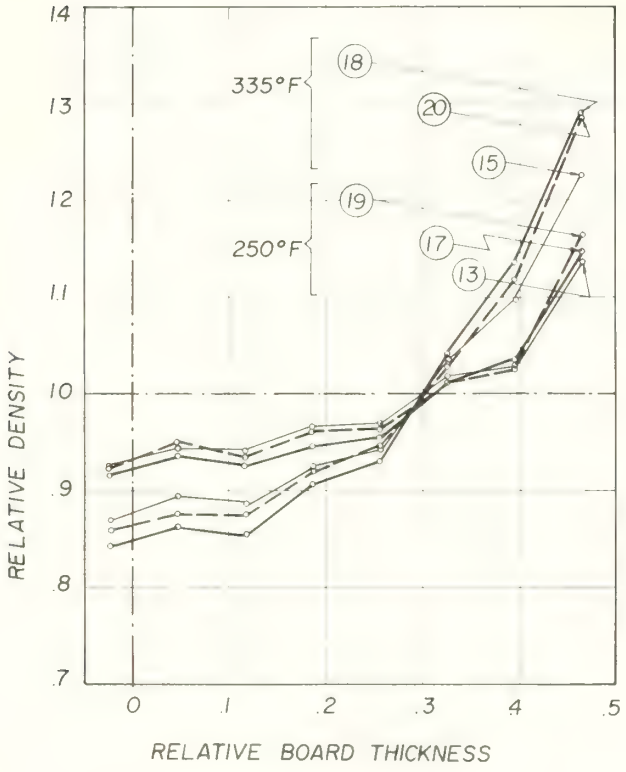


Group No.	Prepressure psi	Pressure psi
3	60	240
7	60	480
11	60	820
15	650	1500
21	pressed in unheated press.	

Figure 3.—*Density profiles of ¾-inch boards pressed at 335°F compared to that of cold-pressed board (No. 21).*

boards were similar to those for comparable ¾-inch boards but had less density contrast from face to core.

Efforts to influence the density distribution by prepressing faces and core at different pressures were not successful (fig. 4). Three-layer boards with cores prepressed at 650 psi and faces at 60 psi had almost identical density profiles as those with cores prepressed at 60 psi and faces at 650 psi. All three-layer boards had more severe density contrast than single-layer boards prepressed at 650 and pressed at 1,500 psi.



Group No.	Prepressure psi		Temperature °F
18	Face:	650	335
	Core:	60	
20	Face:	60	335
	Core:	650	
15		650	335
17	Face:	650	250
	Core:	60	
19	Face:	60	250
	Core:	650	
13		650	250

Figure 4.—*Density profiles of three-layer boards compared with that of single-layer boards pressed at 1,500 psi.*

For all boards, curing temperature of 250°F produced lower face density and higher core density than 335°F. For example, in boards pressed at 480 or 820 psi, face densities were 10 percent lower with 250°F curing than with 335°F.

Density profiles of commercial boards were almost identical to those of the experimental boards with the most severe density contrast (boards pressed at 820 psi and 335°F) (fig. 5). Commercial boards had been sanded on both faces, and experimental boards were unsanded.

Density profiles of boards in the supplemental experiment were almost identical to those of series C (same press cycle).

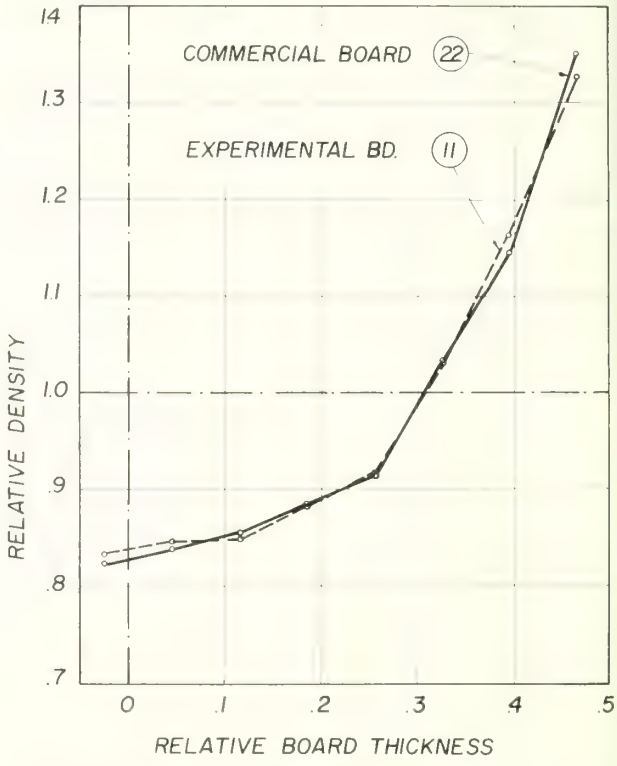


Figure 5.—*Density profile of commercial board compared with that of the experimental board with the most severe density contrast (No. 11—pressed at 820 psi and 335°F).*

Dynamic E Properties

Dynamic E of all ¾-inch experimental boards pressed at 480 psi or greater and at 335°F was greater than the E for commercial boards (table 1). Differences in density alone can not explain the experimental board's su-

perior E, since the board with density profile identical to that of the commercial board had an E of 645,000 psi and the commercial board's was only 531,000 psi. Fiber alignment or species differences could be causing the variation in E.

The dynamic E and density of individual layers were closely correlated when all data were pooled according to cure temperature (fig. 6). Analysis of covariance indicated that the E to density ratio for the commercial boards was lower than that for experimental boards. The close correlation between modulus of elasticity and layer density makes the overall E of the board a good indicator of density contrast.

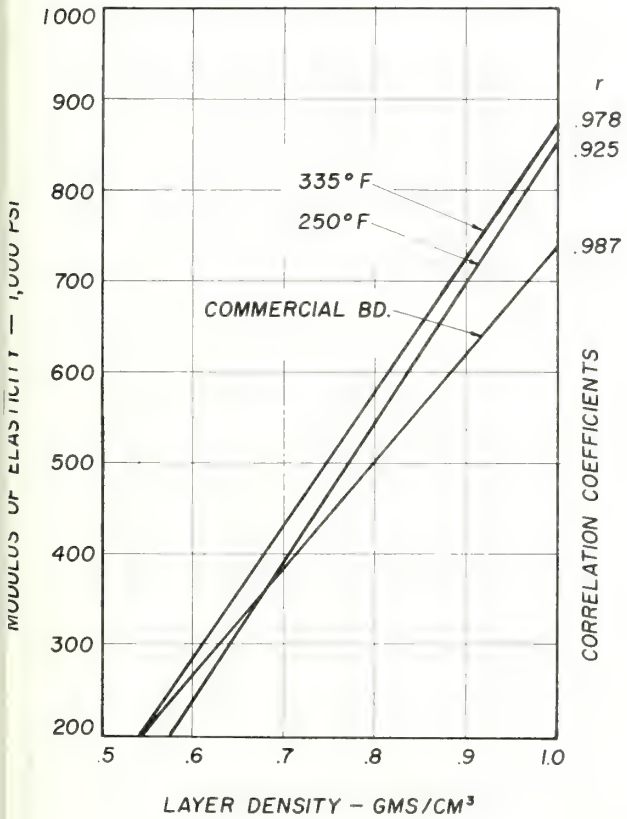


Figure 6.—*Relationship between layer density and modulus of elasticity for all experimental boards pressed at 250°F or 335°F and for commercial board.*

In the supplemental study, regression analysis of E versus layer density indicated that milling the fibers after blending had a limited effect on E (fig. 7). However, covariate analyses (density as the covariate) showed that resin level had no significant effect on E.

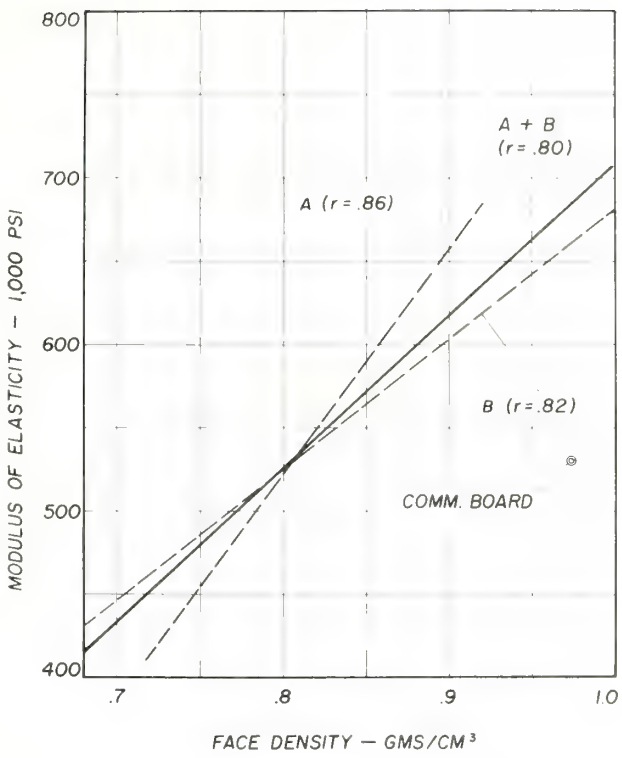


Figure 7.—*Modulus of elasticity as a function of face density for boards in the supplemental experiment (A = boards whose fibers were milled before and after blending; B = boards whose fibers were milled only before blending) and for the commercial board.*

Generally, overall E for the board increases as closing time decreases, but there is a point beyond which closing time will be so short that heat transfer during compression is negligible and therefore density contrast and E are reduced sharply (fig. 8). In commercial operations, zero closing time and uniform density might be achieved by using two presses—the mat would be prepressed cold at such high pressures that it would spring back no further than the final desired board thickness; it would then be put into the hot press. Comparable density and E values could be achieved with long closing times and moderate temperatures. Either technique will yield a board with E and density profile similar to those of the cold press board (series G).

Internal Bond

High internal bond strength is one of the outstanding characteristics of medium-density fiberboard, yet it was difficult to obtain values

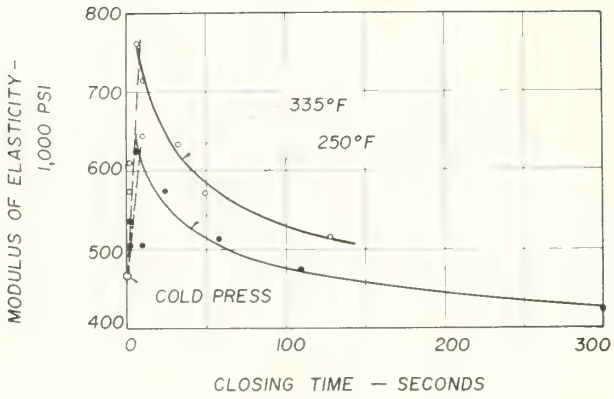


Figure 8.—*Relationship between press closing time and modulus of elasticity for all boards in the main experiment.*

in experimental boards as high as those found in the commercial product (tables 1 and 2). Even at high center densities (fig. 9), the internal bond strength was totally unsatisfactory. Internal bond is sensitive to resin level and resin distribution. In the supplemental experiment, milling before and after blending resulted in dramatic improvements, but even with double milling and 12 percent resin content, IB values were lower than those of the commercial board, which contained 8 percent resin.

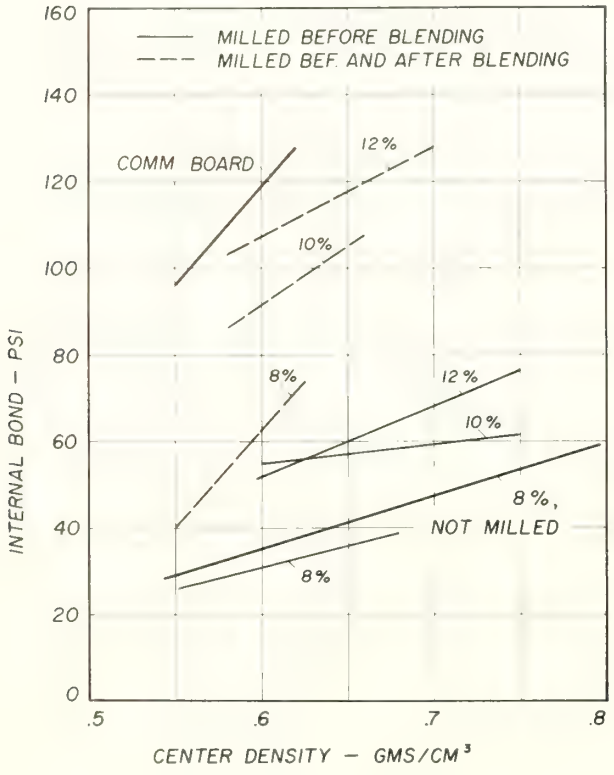


Figure 9.—*Internal bond as a function of core density in experimental and commercial boards. ("8 percent not milled" is a composite value for all boards in the main experiment.)*

Hygroscopic Properties

Average sorption isotherm at 70°F of all boards in the main experiment (fig. 10) indicated the typical depression of the isotherm caused by heat treatment during refining, drying, and pressing (Suchsland 1972). Thickness swelling (48 to 93 percent RH) was higher for experimental boards (13 percent) than for commercial boards (10 percent) (fig. 11). These values are rather high when compared with earlier studies (Suchsland 1973). This discrepancy might be due to the development of mold at the highest relative humidity condition

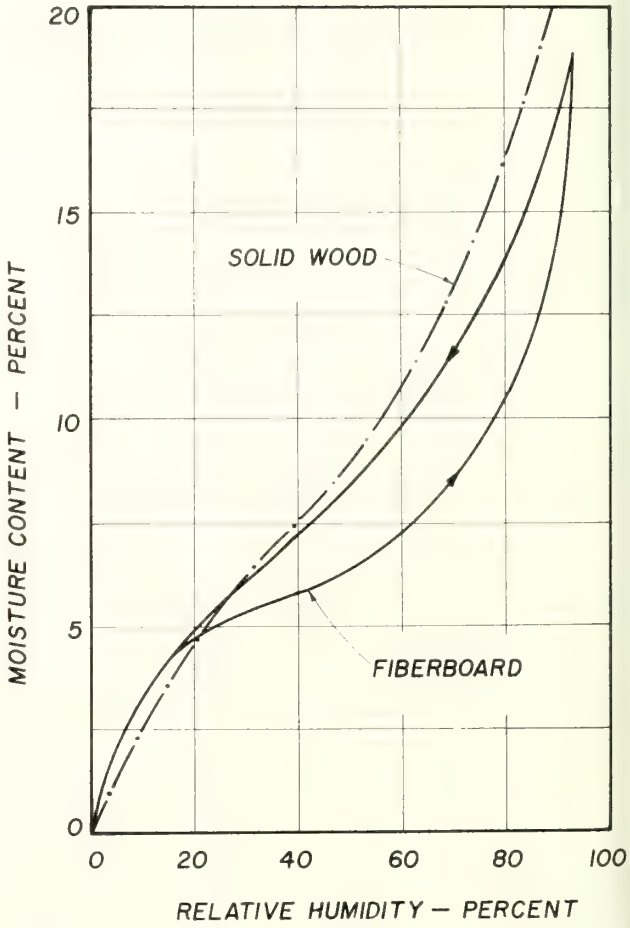


Figure 10.—*Sorption isotherm of fiberboards in the main experiment compared with that of solid wood.*

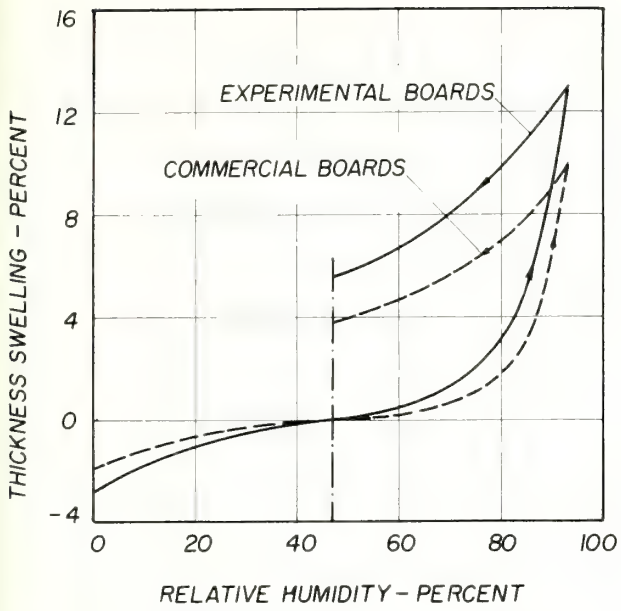


Figure 11.—*Thickness swelling of experimental and commercial medium-density fiberboards.*

necessitating a treatment with permatox solution. In contrast, linear expansion (48 to 90 percent RH) was 0.453 percent for commercial boards and 0.283 percent for experimental boards pressed at 1,500 psi; experimental boards pressed at less than 1,500 psi had intermediate linear expansion (fig. 12).

CONCLUSIONS

The density distribution in boards made with high frequency energy is not necessarily of low contrast and can readily be duplicated in an oil heated press by appropriate adjustment of the press cycle. This conclusion is supported by the experimental data even though differences existed in species composition of commercial and experimental boards.

In addition, some more general conclusions were derived and are offered here in spite of their somewhat speculative character. Density and density distribution directly affect the modulus of elasticity; moreover, they interact with resin level and distribution in developing internal bond strength. A given density profile might result in a satisfactory E but low internal bond strength, as in our experimental boards. One might speculate that the high E is, at least in part, made possible by the mechanical interweaving of fibers in planes parallel to the board surface. If such interweaving could be developed in planes perpendicular to the board surface, internal bond should increase and E should decrease. The markedly low E and the markedly high internal bond of the commercial board seem to suggest that such a vertical alignment of fibers might exist in the commercial board. Its lower thickness

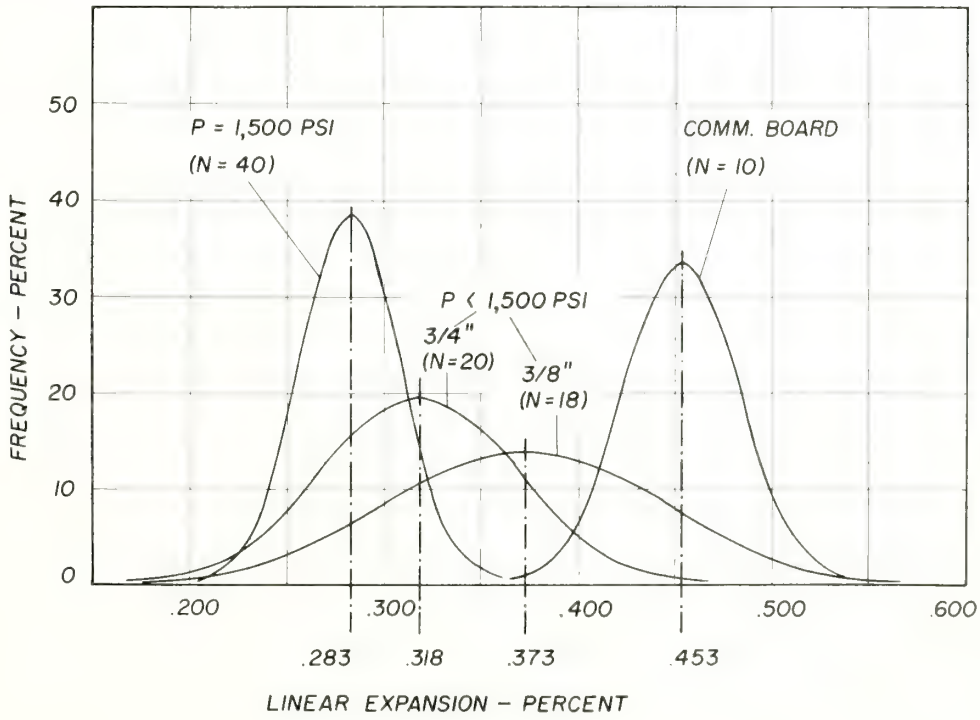


Figure 12.—*Linear expansion of experimental and commercial medium-density fiberboards. N = number of replicates; P = pressure applied during hot-pressing.*

swelling and higher linear expansion than experimental boards support this explanation.

Thus, the actual process of mat formation is vital in obtaining the specific board characteristics desired and must be considered as well as press cycle.

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1976. Properties of medium-density fiberboard produced in an oil-heated laboratory press. South. For. Exp. Stn., New Orleans, La. 10 p. (USDA For. Serv. Res. Pap. SO-116)

Fiberboards from mixed hardwoods produced commercially in a high frequency press had dense face layers (0.98 g/cc) and less dense cores (0.60 g/cc); such density profiles could be duplicated with sweetgum fibers pressed at 335°F and 480 to 820 psi in a conventionally heated press. Because of the close correlation between layer density and layer dynamic modulus of elasticity in experimental fiberboards, controlling the density distribution by manipulating platen temperature and applied pressure also affected overall MOE. Internal bond was affected by resin level and resin distribution.

ADDITIONAL KEYWORDS: Density profiles, modulus of elasticity, platen temperature, internal bond, resin level, resin distribution, *Liquidambar styraciflua*, linear expansion, thickness swell.

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Ranking Forestry Investments With Parametric Linear Programming

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Southern Forest Experiment Station
Forest Service
U.S. Department of Agriculture

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Ranking Forestry Investments With Parametric Linear Programming

Paul A. Murphy

Parametric linear programming is introduced as a technique for ranking forestry investments under multiple constraints; it combines the advantages of simple ranking and linear programming as capital budgeting tools.

Additional keywords. Capital budgeting, financial analysis, investment selection.

Forest land managers and public agencies are often faced with the task of allocating limited funds to a number of competing investments such as precommercial thinning, type conversion, or timber stand improvement. If the only constraint is the amount of money, project selection is straightforward. The ratio of the present value of money received to money spent is calculated for each project, the ratios are ranked, and projects are chosen by moving down the rankings until the funds are exhausted (Lorie and Savage 1955).

When multiple constraints exist, linear programming is needed. Weingartner (1963) applied mathematical programming to capital budgeting including allocation of a fixed sum. Two other studies (Teeguarden and Von Sperber 1968, Buongiorno and Teeguarden 1973) showed that Douglas-fir reforestation projects could best be selected by linear programming.

However, linear programming by itself lacks a useful feature of simple ranking. Ranking provides a solution for all levels of funding; linear programming gives a solution for only one. Other constraints such as manpower, equipment, and nursery capacity are usually known in advance, but funding is different. Annual budgets may be allocated at a different organization level. Consequently, the exact amount is not known far in advance and may change. A ranking of projects would circumscribe this problem, if it could be done under multiple constraints.

This paper describes a procedure for ranking forestry investments that are bound by multiple constraints. This procedure—which uses parametric linear programming—combines the advantages of simple ranking and linear programming.

Model Formulation

Parametric linear programming is applied to a problem only after an initial solution has been found by the simplex method. The dual simplex method—the algorithm used for parameterization—is then applied to the primal problem. Both methods use the same notation. For these reasons, the simplex method will be outlined briefly, and then parametric linear programming and its application to ranking investments will be discussed. The notation and development used here are from Hadley (1962).

The typical linear programming problem is

$$\max z = c'x,$$

subject to the restrictions,

$$Ax = b, \tag{1}$$

$$x \geq o, \tag{2}$$

where A is an m x n matrix, x and b are n x 1 column vectors, c' is a 1 x n row vector, and o is an n x 1 vector of zeroes.

If the matrix B is composed of m linearly independent columns of A, then any column a_j of A can be written as a linear combination of the columns of B,

$$a_j = By_j. \tag{3}$$

This matrix B also provides a basic solution to the simultaneous linear equations represented by equation (1). This solution x_B is determined as follows:

$$x_B = B^{-1}b.$$

Corresponding to a basic solution x_B, there is an associated price vector c_B, which is composed

of m elements from vector c.

A basic solution which satisfies restriction (2) is called a basic feasible solution. Assuming there is a basic feasible solution, the simplex method provides a means of improving it—that is, increasing the value of

$$z = c_B' x_B. \tag{4}$$

Equation (3) may be rewritten as

$$a_j = \sum_{i=1}^{m} y_{ij} b_i.$$

Any vector b_r in the basis may be written in terms of the remaining basis vectors and a vector a_j not in the basis.

$$b_r = a_j y_{rj} - \sum_{\substack{i=1 \\ i \neq r}}^{m} y_{ij} b_i y_{rj}.$$

By substituting a_j for b_r, a new basic solution is obtained,

$$b = \sum_{\substack{i=1 \\ i \neq r}}^{m} x_{Bi} b_i + x_{Br} [a_j y_{rj} - \sum_{i=1}^{m} y b_i y_{rj}]$$

For the new solution to be feasible,

$$x_B - x_{Br} y_{rj} y_{rj} \geq 0, \; i \neq r$$
$$\frac{x_{Br}}{y_{rj}} \geq 0, \; i = r.$$

To maintain feasibility, the vector b_r to be replaced is determined by

$$x_{Br}/y_{rj} = \min_j \{x_{Bi} y_{rj}, y_{rj} > 0\}$$

The vector to enter should improve the basic feasible solution. Equation (4) may be rewritten with a_j substituted for b_r,

$$z = \sum_{\substack{i=1 \\ i \neq r}}^{m} [x_{Bi} - x_{Br} y_{rj}] c_{Bi} + x_{Br} c_j y_{rj}. \tag{5}$$

Since

$$c_{Bi} (x_{Br} - x_{Br} y_{rj} y_{rj}) = 0,$$

the $i=r$ term can be included in the summation, and equation (5) becomes

$$\hat{z} = \sum_{i=1}^{m} x_{Bi} c_{Bi} - x_{Br} y_{rj} \sum_{i=1}^{m} y_{ij} c_{Bi} + x_{Br} c_j y_{rj},$$

which is reduced to

$$\hat{z} = z + [c_j - \sum_{i=1}^{m} y_{ij} c_{Bi}] x_{Br}/y_{rj}. \tag{6}$$

For there to be an increase in the objective function,

$$c_j - \sum_{i=1}^{m} y_{ij} c_{Bi} > 0.$$

The usual criterion for selecting the vector to enter is to pick the one with the maximum $(c_j - z_j)$, where

$$z_j = \sum_{i=1}^{m} y_{ij} x_{Bi}. \tag{7}$$

Given a basic feasible solution, a new basic feasible solution with an improved objective function can be found by the simplex method. The process can terminate in two ways:

(1) one or more $z_j - c_j < 0$, and for each $z_j - c_j < 0$, $y_{ij} \leq 0$ for all $i=1, \ldots, m$

(2) all $z_j - c_j \geq 0$ for the columns of A not in the basis.

If situation (2) occurs, there is an optimal basic feasible solution.

Suppose there is an optimal basic feasible solution. We want to increase or decrease the constraints by changing the requirements vector b,

$$b^* = b + \Theta r.$$

The vector r is specified, and Θ is a non-negative scalar (Hadley 1962, p. 382). Changing b changes the solution, which becomes

$$x_B^* = B^{-1}(b + \Theta r),$$
$$= x_B + \Theta r.$$

Even though the solution x_B^* changes, optimality is maintained as long as the solution remains feasible because the values of the $z_j - c_j$'s are affected only by the basis vectors and not by the solution vector. If any of the v_i's in vector v are negative, the point where the first x_{Bi} becomes less than or equal to zero is

$$\Theta = \min_i \{-x_{Bi}/v_i, v_i < 0\}. \tag{8}$$

The dual simplex algorithm can be applied in this situation. Given a solution that is infeasible but where all $z_j - c_j$'s ≥ 0 for vectors not in the basis, the dual simplex can be used to obtain a basic feasible solution while preserving $z_j - c_j \geq 0$ for all nonbasis vectors. Once a basic feasible solution is reached, it is also optimal.

The vector to leave the basis is already known by equation (8). Only the vector to enter the basis remains to be determined.

Given the primal problem,

$$Ax = b, x \geq 0, \max z = c'x,$$

the dual formulation is

$$A'w \geq c, \min Z = b'w,$$
$$A'w \geq c, \tag{9}$$

where the w_i's are unrestricted in sign.

If the primal solution has all $z_j - c_j \geq 0$ for all vectors not in the basis and one of the x_{Bi}'s is negative, the corresponding solution to the dual w is not optimal.

Consider a new vector $\hat{w}$, which is given by

$$\hat{w} = w - \theta\beta_r ,$$

where β_r is a vector of B^{-1} (Hadley 1962, p. 245). For all a_j not in the primal basis,

$$\hat{w}'a_j = w'a_j - \theta\beta_r'a_j$$
$$= w'a_j - \theta y_{rj}$$

Substituting $\hat{w}'a_j$ into the inequality from (9), we have

$$w'a_j - \theta y_{rj} \geq c_j .$$

Let us now consider $c_B'B^{-1}$ as a solution for w', or

$$w' = c_B'B^{-1}$$

For it to be a solution, only the inequality $A'w \geq c$ need be satisfied.

$$c_B'B^{-1}A \geq c'.$$
$$c_B'B^{-1}a_j \geq c_j.$$

Since $y_j = B^{-1}a_j$,

$$c_B'y_j \geq c_j .$$

From relation (7), it may be written as

$$z_j \geq c_j, \text{ or } z_j - c_j \geq 0,$$

which is a characteristic of the original problem. Hence,

$$c_B'B^{-1}a_j - \theta y_{rj} \geq c_j ,$$
$$z_j - \theta y_{rj} \geq c_j$$
$$\theta y_{rj} \leq z_j - c_j. \qquad (10)$$

Before we derive the criterion for the vector to enter from expression (10), let us look again at equation (6). For there to be an increase in the objective function

$$x_{Br}(c_j - z_j)/y_{rj} \geq 0.$$

If x_{Br} were just slightly negative, y_{rj} would have to be less than zero for $z \geq z$, since $c_j - z_j \leq 0$. Therefore $y_{rj} < 0$ in expression (10), and it follows that $\theta < 0$.

For a maximum increase in the objective function, the vector a_k to enter the basis is determined by

$$\theta = (z_k - c_k)/y_{rk} = \max (z_j - c_j)/y_{rj},$$
$$y_{rj} < 0. \qquad (11)$$

As elements of the requirements vector are changed by right-hand side parameterization, a series of optimal bases develops. The vector to leave and the vector to enter the basis at each step are determined by expressions (8) and (11), respectively.

Let us return to our original problem. We are faced with deriving a set of priorities from a set of investment projects under multiple constraints. Given a certain budget, linear programming can select the set of projects that maximizes net present value. With parametric linear programming, sets of investment projects can be selected for different ranges of funding. A list of priorities that is valid for any level of funding can be derived in the following manner.

The funding level in the original requirements vector is set equal to or less than the amount of money required for the smallest project. This procedure insures that no more than one project enters into the initial solution. Then the simplex method or other procedure is used to arrive at an optimal basic feasible solution. Next the budget level is varied—that is, increased—by means of parametric linear programming. As the budget level is increased, projects enter the solution one by one. The order in which the investments enter the solution determines their priority for two reasons. A given solution remains optimal over the region in which it remains feasible, and once a solution is no longer feasible, the dual simplex procedure selects a vector to enter the basis such that the new solution is both optimal and feasible.

Examples

Most linear programming systems now available can also do either right-hand side or objective row parameterization. The UNIVAC 1108 Linear Programming System was used for the following examples. Ranking was first done with the funding level as the only constraint to illustrate that ranking with parametric linear programming is equivalent to simple ranking when only one restriction exists. The second example illustrates the effectiveness of ranking with parametric linear programming when multiple constraints exist.

As the result of succession often aided by timber cutting practices, extensive acreages of pine sites in the South are now dominated by hardwood forest types. Converting these hardwood stands to pine offers one of the best ways of increasing the region's pine timber supply. In southern Alabama alone, over 3 million acres of private, nonindustrial forest land could be converted to pine (table 1). To set priorities these lands were classified according to the size of the hardwood stand now occupying the site, the pine species to be regenerated, the site index of the

Table 1.—*Type conversion opportunities on pine sites in southern Alabama, 6 percent interest rate, miscellaneous private owners, 1972*

Number	Present stand size	Species	Type of regeneration	Site index	Area	Net present value	Conversion cost
				Feet	*Thousand acres*	*——Dollars/acre——*	
1	sawtimber	shortleaf[1]	natural	92	22.7	104.36	39.70
2	"	"	"	80	34.7	68.38	39.70
3	all other	"	"	89	18.5	96.07	38.60
4	"	"	"	79	34.8	66.78	38.50
5	"	"	"	65	21.6	30.40	38.80
6	"	slash[2]	"	76	25.6	11.53	38.90
7	sawtimber	"	"	72	23.6	1.17	38.50
8	all other	"	planting	81	135.6	55.60	56.62
9	"	"	"	74	170.2	12.92	56.42
10	"	longleaf[3]	natural	78	87.2	—14.32	38.60
11	"	"	"	61	58.7	—26.00	38.40
12	sawtimber	"	"	79	35.2	—13.25	38.40
13	all other	loblolly[4]	"	100	44.3	218.08	38.80
14	"	"	"	86	304.8	140.90	38.60
15	"	"	"	72	232.5	91.04	38.70
16	sawtimber	"	"	101	102.2	226.66	40.60
17	"	"	"	87	164.9	146.80	40.00
18	"	"	"	75	111.3	101.09	39.90
19	all other	"	planting	100	57.0	341.12	57.92
20	"	"	"	84	618.4	132.01	57.02
21	"	"	"	73	529.0	42.56	57.12
22	"	"	"	56	34.9	—28.41	56.32
23	sawtimber	"	"	106	28.5	445.57	59.82
24	"	"	"	86	187.1	150.57	59.22
25	"	"	"	75	67.1	53.32	59.72
					3,150.4		

[1] *Pinus echinata* Mill.
[2] *Pinus elliottii* Engelm.
[3] *Pinus palustris* Mill.
[4] *Pinus taeda* L.

pine species, and the type of regeneration. Information for formulating the linear programming problem included the acreage, net present value, and conversion cost for each class.

Net present value was calculated assuming a perpetual series of rotations to insure comparability among the classes. If only one rotation were considered, the net present value of one conversion class would not be directly comparable to that of another class with a different rotation length. To further assure comparability, classes with artificial regeneration were assumed to be followed by a sequence of natural stands rather than plantations.

The problem is

$$\max \sum_{i=1}^{n} p_i x_i,$$

subject to the constraints

$$0 \leq x_i \leq a_i,\ i = 1, n$$

$$\sum_{i=1}^{n} c_i x_i \leq d,$$

where x_i is the acreage in the ith opportunity class to be converted, a_i is the amount of land in the ith class available for type conversion, p_i is the net present value of converting 1 acre of the ith class to pine, c_i is the cost of converting 1 acre of the ith class to pine, and d is the amount of funds available for type conversion. Initially, d is set at a level such that

$$d \leq \min\{c_i a_i\}$$

For this problem, the third type conversion opportunity in table 1 has the minimum $c_i a_i$, which is $714,100. Hence, the initial value of d should be less than this amount; I set it at $1,000.

An optimal basic feasible solution to the problem was found. Right-hand side parameterization was then applied to the problem. A column vector r was specified so that the value of d was increased through right-hand side parameterization.

The priorities that resulted (table 2) are the same as those obtained by simple ranking of the ratios of net present value to conversion cost.

A more realistic approach would be to include nursery capacity constraints in the problem.

The total acreage that could be planted to slash (*Pinus elliottii* Engelm.) or loblolly (*P. taeda* L.) pine is 1.8 million acres. If planting density is 8 x 8 feet or 680 trees per acre, the total number of seedlings required would be 1.2 billion.

Let s and f be the maximum acreages that can be planted to slash and loblolly pines, respectively. The following constraints are then added to the problem,

$$\Sigma x_j \leq s, \; j = 8,9$$
$$\Sigma x_k \leq f, \; k = 19,20, \ldots\ldots,25$$

The maximum acreage that can be planted to slash pine will be 33,000 acres; the maximum for loblolly pine will be 67,000 acres. The remaining variables are unchanged.

When the nursery constraints are added, only three classes with artificial regeneration are in the rankings, (table 3); there were eight in table 2. The maximum aggregate cost is reduced by two-thirds as the result of the imposition of these additional restrictions.

Of course, the type conversion classes could have been ranked under nursery capacity restrictions without parametric linear programming. By totaling the acreages of each class that utilized planting, one could determine the point in the rankings where nursery capacity would be exhausted. All classes below this point that used planting would be deleted from the list. However, the problems presented in tables 2 and 3 are simple. More complex problems would be exceedingly difficult, if not impossible, to solve in this manner.

This technique should prove useful in two ways. It lessens the necessity to resolve problems because of unanticipated changes in constraint levels, and it increases the capability of linear

Table 2.—*Ranking of type conversion opportunities for southern Alabama*

Rank	Number	Net present value / Conversion cost	Cumulative cost	Cumulative area planted	
				Slash	Loblolly
			Thousand dollars	— — *Thousand acres* — —	
1	23	7.44	1,705		28.5
2	19	5.89	5,006		85.5
3	13	5.62	6,725		85.5
4	16	5.58	10,874		85.5
5	17	3.67	17,470		85.5
6	14	3.65	29,236		85.5
7	1	2.63	30,137		85.5
8	24	2.54	41,217		272.6
9	18	2.53	45,657		272.6
10	3	2.49	46,372		272.6
11	15	2.35	55,370		272.6
12	20	2.32	90,631		891.0
13	4	1.73	91,971		891.0
14	2	1.72	93,348	0.0	891.0
15	8	.98	101,026	135.6	891.0
16	25	.89	105,033	135.6	958.1
17	5	.78	105,871	135.6	1,487.1
18	21	.75	136,087	135.6	1,487.1
19	6	.30	137,083	135.6	1,487.1
20	9	.23	146,686	305.8	1,487.1
21	7	.03	147,595	305.8	1,487.1

Table 3. *Ranking of type conversion opportunities for southern Alabama with nursery capacity as a constraint*

Rank	No.	Cumulative cost	Cumulative area planted		Solution value
			Slash	Loblolly	
		Thousand dollars	*Thousand acres*		—
1	23	1,705		28.5	28.5
2	19	3,935		28.5	38.5
3	13	5,654		67.0	44.3
4	16	9,803		67.0	102.2
5	17	16,399		67.0	164.9
6	14	28,164		67.0	304.8
7	1	29,065		67.0	22.7
8	18	33,506		67.0	111.3
9	3	34,220		67.0	18.5
10	15	43,217		67.0	232.5
11	4	44,558		67.0	34.8
12	2	45,936	0.0	67.0	34.7
13	8	47,804	33.0	67.0	33.0
14	5	48,642	33.0	67.0	21.6
15	6	49,638	33.0	67.0	25.6
16	7	50,547	33.0	67.0	23.6

programming as an investigative and planning tool. In addition, using parametric linear programming to rank projects under multiple constraints has other uses. For example, one can investigate the sensitivity of the rankings to different interest rates or stumpage prices.

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Maximizing Returns from Investment In Type Conversion: A Case Study

Paul A. Murphy

Southern Forest Experiment Station
Forest Service
U.S. Department of Agriculture

1976

Maximizing Returns From Investment In Type Conversion: A Case Study

Paul A. Murphy

Parametric linear programming is used to rank type conversion opportunities on the Alabama Coastal Plain under multiple constraints. The procedure can guide allocation of forestry investment funds to areas which offer the best economic potential, and it can predict the impact different levels of investment might have on regional timber supplies. It has application to other geographic areas and stand treatments.

Additional keywords: Parametric linear programming, type conversion, economic analysis, forest investment.

The South is the region of the United States with the greatest potential for increasing its timber supply (McGuire 1974). The major opportunity lies in converting sites suitable for growing pine but now occupied by low-quality hardwoods to the preferred species. Thirty-six million acres of such sites are located in the South's Coastal Plain; hence, the problem of deciding where to channel available funds is enormous. A system to classify and rank conversion opportunities is needed to insure that money from such Federal sources as the Forestry Incentives Program (FIP) is allocated to areas which offer the best economic potential and to help private firms in choosing among conversion opportunities on their holdings.

A number of earlier studies (Gansner and others 1973, Fight and Gedney 1973, Knight and McClure 1974, Anderson 1968) identified regional timber investment opportunities; however, none considered the problem of investment when restrictions such as limited funds exist. Buongiorno and Teeguarden (1973) used linear programming to schedule Douglas-fir reforestation under multiple constraints, but a linear programming solution is valid for only one funding level. In the present study, a procedure is applied that identifies the various type conversion opportunities on private, nonindustrial ownerships, evaluates the economic potential of each opportunity, and measures the contribution of type conversion to the regional timber supply; moreover, it provides solutions for any funding level by ranking the investment opportunities under multiple constraints.

MODEL DEVELOPMENT

The study area encompasses the Alabama Coastal Plain (fig. 1). Most of the basic data for the study is from the latest inventory of Alabama's forests (Murphy 1973).

Classifying Conversion Opportunities

Site conversion opportunities were classified by type of regeneration needed, size, and site quality.

Regeneration to a new stand, either by natural means or by planting, was considered essential for expeditious type conversion. If an adequate pine seed source was present, natural regeneration to the most plentiful pine species was assumed. If an adequate seed source was not present, regeneration would be by planting either loblolly (*Pinus taeda* L.) or slash (*P. elliottii* var. *elliottii* Engelm.) pine. Slash pine would be planted in the lower counties—Baldwin, Covington, Escambia, Geneva, Houston, Mobile, and Washington—and loblolly in the other counties because these are the areas where each species naturally predominates (USDA FS 1969).

Because site preparation cost varies with stand size, sawtimber stands were separated from smaller stands. The number of hardwood trees 10 inches or larger in diameter was then calculated for the two size classes.

Site quality for pine was determined from index trees on the site (table 1). If stands scheduled for planting had no site index trees of the correct species, they were assigned the average site index for the county.

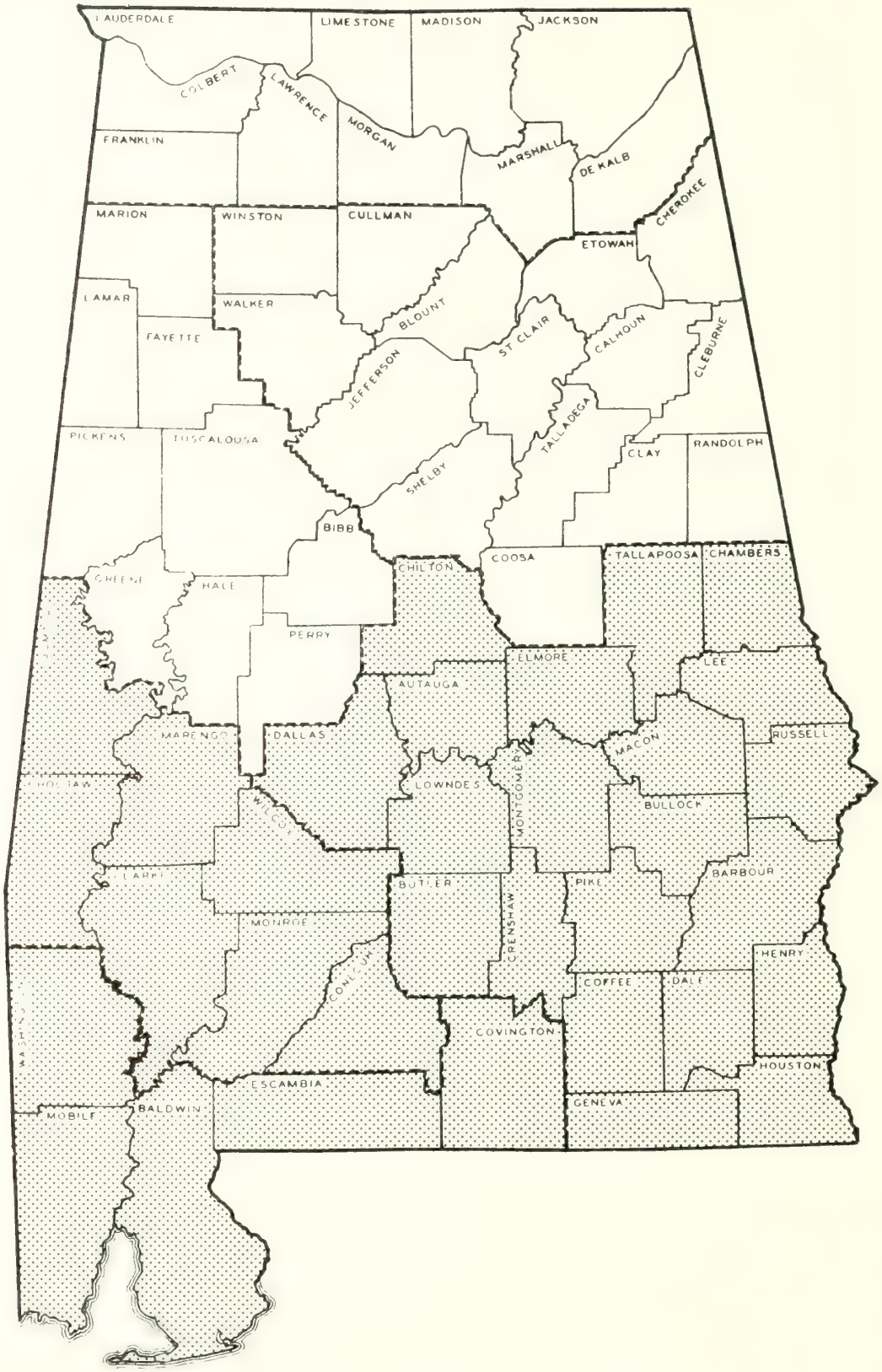

Figure 1.—*Study area in southern Alabama.*

Table 1.– *Site classes by site index for the major southern pines*

Site class	Site index (50-year basis)			
	Loblolly	Longleaf	Shortleaf	Slash
	Feet			
1	95+	...	86+	93+
2	80–94	89+	72–85	80–92
3	60–79	68–88	54–71	62–79
4	51–59	49–67	38–53	43–61

With six species-regeneration possibilities, two size classes, and three site-quality classes for longleaf (*P. palustris* Mill.) and four for the other species, there were 46 possible categories of conversion opportunities.

After the conversion categories were established, Forest Survey plots on private, nonindustrial land in the study area were screened to find those occurring in a hardwood stand on a pine site. (Survey plots are permanently established by the Forest Service at intersections of a 3-mile grid across the Midsouth.) Since each plot represented from 4,300 to 6,900 acres, its site index and the number of large hardwood trees were weighted by an appropriate area expansion factor. Average site index and average number of hardwood trees over 10 inches in diameter per acre were then calculated for each conversion category. Plot expansion factors were accumulated to compute the acreage in each class.

The screening revealed plots in 33 conversion classes, but classes with less than 15,000 acres were discarded because of too much sampling error. This deletion left 25 conversion classes (or projects) with a total of 3.2 million acres (table 2). About 58 percent of the acreage must be regenerated by planting (table 3). Only 1.3 million acres have a pine seed source adequate for natural regeneration. Almost four-fifths of the total can be regenerated to loblolly, which is the predominant pine species in the South (Sternitzke and Nelson 1970).

Determining Treatments

Management schedules.—For all stands, initial establishment entails site preparation with heavy machinery, poisoning of all hardwood stems over 10 inches in diameter, and a preparatory burn. The high proportion of unmerchantable hardwoods on these pine sites necessitates this type of site preparation.

In naturally regenerated stands, seed trees are not harvested until seedlings are established—usually 3 years for loblolly and slash pines, 4 years for shortleaf, and 5 for longleaf. When the stand is about 3 years old, a precommercial thinning is done to control density and improve spacing. Longleaf pine is not thinned because its sparse seed production does not produce dense stands and the early expression of dominance lessens the need for thinning.

Spacing for the plantations was set at 8 feet by 8 feet, which results in about 680 trees per acre. This spacing is a compromise between a wide one for sawtimber and a close one for pulpwood.

Both naturally regenerated and planted stands are burned every 4 years beginning at age 15 for hazard reduction and hardwood control. Such a burning program also eliminates the need for extensive site preparation at the end of the rotation. In addition, longleaf stands are burned to control brownspot after seed tree removal and before initiation of height growth.

In plantations as well as naturally regenerated stands, the overstory is harvested at rotation age, but seed trees are left intact to insure a succession of natural stands. For loblolly, shortleaf (*P. echinata* Mill.), and slash pines, the stocking standard for seed trees is 10 ft^2 of basal area per acre. Longleaf pine is regenerated under a shelterwood with a density of 30 ft^2 per acre. After the harvest cut, the area is burned to prepare the site.

Economic evaluation.—Net present value was chosen as the investment criterion. Internal rate of return was not chosen because it can lead to an incorrect choice when deciding between a set of investments and because an investment might have two or more internal rates (Gansner and Larsen 1969). Net present value, on the other hand, is unique for a given investment and interest rate. Furthermore, net present values of investments are additive, and additivity is a necessary characteristic for an investment criterion to be used in linear programming.

The yield models of Schumacher and Coile (1960) were used to predict the volumes of natural stands. The plantation yield model of Bennett and Clutter (1968) was selected for slash pine, and that of Lenhart and Clutter (1971) was chosen for loblolly pine. Although both are for old-field stands, they were used because models are not available for planted forest sites. Yields

Table 2.—*Type conversion opportunities on pine sites in southern Alabama, private nonindustrial owners, 1972*

Project number	Species	Type of regeneration	Stand size	Site class	Hardwoods ≥10 in d.b.h.	Area
					No./acre	*Thousand acres*
1	Shortleaf	natural	other	1	10	18.5
2	"	"	"	2	9	34.8
3	"	"	"	3	12	21.6
4	"	"	sawtimber	1	21	22.7
5	"	"	"	2	21	34.7
6	slash	"	other	3	13	25.6
7	"	"	sawtimber	3	9	23.6
8	"	planting	other	2	8	135.6
9	"	"	"	3	6	170.2
10	longleaf	natural	"	3	10	87.2
11	"	"	"	4	8	58.7
12	"	"	sawtimber	3	8	35.2
13	loblolly	"	other	1	12	44.3
14	"	"	"	2	10	304.8
15	"	"	"	3	11	232.5
16	"	"	sawtimber	1	30	102.2
17	"	"	"	2	24	164.9
18	"	"	"	3	23	111.3
19	"	planting	other	1	21	57.0
20	"	"	"	2	12	618.4
21	"	"	"	3	13	529.0
22	"	"	"	4	5	34.9
23	"	"	sawtimber	1	40	28.5
24	"	"	"	2	34	187.7
25	"	"	"	3	39	67.1
						3,150.4

Table 3.—*Type conversion opportunities in southern Alabama by species and type of regeneration*

Species	Type of regeneration		All types
	Natural	Planting	
	Thousand acres — — —		
Shortleaf	132.3	...	132.3
Slash	49.2	305.8	355.0
Longleaf	181.1	...	181.1
Loblolly	960.0	1,522.0	2,482.0
All species	1,322.6	1,827.8	3,150.4

on forest sites that are well site-prepared should approach those on old fields of comparable site quality.

A rotation age of 30 years was set for plantations because the data on which the plantation yield models were based do not extend beyond 30 years and because this is the minimum age at which a sizable seed crop can be expected. The rotation ages for natural stands were set equa to the year in which net present value is maxi mum, subject to the restriction that the mini mum rotation age be 40 years. In natural stands seed production does not become reliable no sawtimber production worthwhile until age 40

Stumpage prices were calculated at $6 pe cord, or 7.4 cents per cubic foot, for pulpwoo and $69.52 per thousand board feet (Int. 1/4 inch rule) for sawtimber. These prices were obtained from the Louisiana Department of Agriculture (1974).

Costs incurred during type conversion and management of the new stands are listed in table 4. After the first rotation, the only site preparation cost would be $1.50 per acre for a control burn.

All costs and returns were assumed to be known with certainty and not subject to changes. The inclusion of risk and uncertainty is beyond the scope of this analysis. Land value and taxes

Table 4.—*Estimated average costs of forestry practices in southern Alabama*[1]

Practice	Cost
	Dollars
Site preparation	34.10/acre
Tree injection	0.10/stem
Burning during conversion	3.50/acre
Planting	
Seedlings	7.50/thousand
Planting cost	13.12/acre
Burning for hardwood control	1.50/acre
Precommercial thinning	14.00 acre

[1] Data sources: Alabama Forestry Commission, Alabama National Forests, and 1972 Rural Environmental Assistance Program records from selected Agricultural Stabilization and Conservation Service county offices.

were not included in the calculations. Since land is not bought or sold, it is a constant and does not enter into the equation. The effect of taxes depends not only upon the status of the forest stand but also on other factors—such as income or number of dependents—that vary by owner. Since this study is not a tract analysis, taxes were not considered.

Linear Programming

Parametric linear programming was used to rank the projects according to the criterion of maximizing net present value, as described previously (Murphy 1976). To use parametric linear programming, a solution to the standard linear programming problem must be found. The formulation of investment selection as linear programming problem is straightforward. It is

$$\max \sum_{i=1}^{n} p_i x_i, \qquad (1)$$

subject to the constraints,

$$0 \leq x_i \leq a_i, \; i = 1,2,\ldots,n \qquad (2)$$

$$\sum_{i=1}^{n} c_i x_i = d, \qquad (3)$$

where x_i is the acreage in the ith treatment class, a_i is the amount of land in the ith class available for type conversion, p_i is the net present value of converting 1 acre of the ith class to pine, c_i is the total cost of converting 1 acre of the ith class to pine, and d is the amount of funds available for type conversion. The funding restriction (3) was expressed as an equality to force total utilization of available funds.

RESULTS

The aggregate cost of converting all hardwood stands on pine sites in southern Alabama is almost $157 million, a level of investment that appears unlikely. However, the rankings of the projects indicate the order in which they should be funded to maximize net present value for any level of investment (table 5). For example, if $46 million is available, only projects ranking from first to tenth should be funded.

Examination of the rankings reveals an underlying pattern. Since cost does not differ greatly for site preparation, target species and site quality affect net present values the most. Loblolly pine dominates the early rankings almost exclusively; its preeminence is not surprising since this species makes up almost half the pine volume in the South. Shortleaf pine, though not a predominant species in the southern Coastal Plain of Alabama, comes in second to loblolly.

Table 5.—*Ranking of type conversion opportunities for southern Alabama, 6 percent interest rate*

Rank	Project number	Cumulative cost	Cumulative area planted	
			Slash	Loblolly
		Thousand dollars	*Thousand acres*	
1	23	1,705		28.5
2	19	5,006		85.8
3	13	6,725		85.8
4	16	10,874		85.8
5	17	17,470		85.8
6	14	29,236		85.8
7	4	30,137		85.8
8	24	41,217		272.6
9	18	45,657		272.6
10	1	46,372		272.6
11	15	55,370		272.6
12	20	90,631		891.0
13	2	91,971		891.0
14	5	93,348	0.0	891.0
15	8	101,026	135.6	891.0
16	25	105,033	135.6	958.1
17	3	105,871	135.6	958.1
18	21	136,087	135.6	1,487.1
19	6	137,083	135.6	1,487.1
20	9	146,686	305.8	1,487.1
21	7	147,595	305.8	1,487.1
22	12	148,946	305.8	1,487.1
23	10	152,311	305.8	1,487.1
24	22	154,277	305.8	1,522.0
25	11	156,432	305.8	1,522.0

Only a few slash pine classes are intermixed with the shortleaf and loblolly. Longleaf pine is last in the rankings because its delayed height growth puts this species at a distinct disadvantage. Within a given species, conversion classes with good site quality have a high priority regardless of the mode of regeneration.

The impact of different funding levels on the timber supply can also be evaluated with parametric linear programming (fig. 2). As time progresses, the effect of different investment levels on the inventory becomes more pronounced.

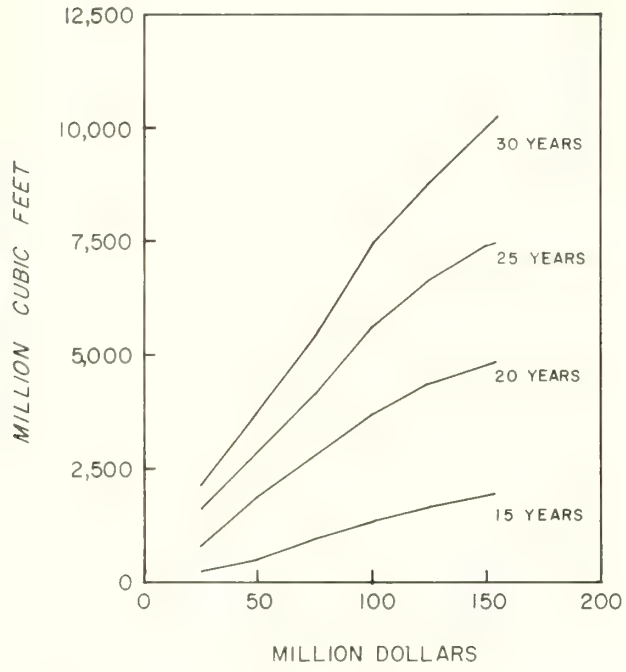

Figure 2.—*Timber supply resulting at various years from type conversion with different levels of funding and 6 percent interest rate.*

Other restrictions besides funding can also be considered with this procedure. For example, incidence of fusiform rust, a common disease of young loblolly and slash pines, is high in southern Alabama (Wakeley 1954). One means of combatting this disease is planting rust resistant stock. But the supply of such seed is small. How can funds be optimally allocated to type conversion when the availability of resistant stock is limited? Suppose there are enough resistant seedlings to plant 33,000 acres to slash pine and 67,000 acres to loblolly pine and no areas will be planted with seedlings of low resistance. The ranking of projects changes somewhat, and the amount of money that could be spent on type conversion is reduced by almost two-thirds (table 6). However, the possibility of catastrophic loss due to fusiform rust is minimized.

Table 6.—*Ranking of type conversion opportunities with supply of rust-resistant seedlings as a constraint, 6 percent interest*

Rank	Project number	Cumulative cost	Cumulative area planted		Solution value
			Slash	Loblolly	
		Thousand dollars	— *Thousand acres* —		
1	23	1,705		28.5	28.5
2	19	3,935		67.0	38.5
3	13	5,654		67.0	44.3
4	16	9,803		67.0	102.2
5	17	16,399		67.0	164.9
6	14	28,164		67.0	304.8
7	4	29,065		67.0	22.7
8	18	33,506		67.0	111.3
9	1	34,220		67.0	18.5
10	15	43,217		67.0	232.5
11	2	44,558	0.0	67.0	34.8
12	5	45,936	0.0	67.0	34.7
13	8	47,804	33.0	67.0	33.0
14	3	48,642	33.0	67.0	21.6
15	6	49,638	33.0	67.0	25.6
16	7	50,547	33.0	67.0	23.6
17	12	51,898	33.0	67.0	35.2
18	10	55,263	33.0	67.0	87.2
19	11	57,418	33.0	67.0	58.7

Similarly, if disease-resistant stock is not needed but the seedling supply is limited by nursery capacity, that restriction on planted acreages could be entered into the problem in lieu of the 67,000 and 33,000 acres of the previous example.

The use of net present value as an investment criterion raises the spectre of what interest rate to select. Fortunately, parametric linear programming not only offers a way to rank investments under multiple constraints but also can reveal the responsiveness of the rankings to changes in interest rates.

The basic data were subjected to parametric linear programming with different interest rates (table 7). There were some shifts in the rankings as interest rates went from 6 to 10 percent. The conversion opportunities in shortleaf tended to slip in the rankings, longleaf stayed at the bot-

Table 7.—*Ranking of type conversion opportunities with different interest rates*

Rank	Interest rate				
	0.06	0.07	0.08	0.09	0.10
1	23	23	23	23	13
2	19	19	13	13	16
3	13	13	16	16	23
4	16	16	19	19	17
5	17	17	17	17	14
6	14	14	14	14	18
7	4	18	18	18	15
8	24	15	15	15	19
9	18	24	24	24	24
10	1	20	20	20	20
11	15	4	4	4	8
12	20	1	1	1	4
13	2	2	2	8	25
14	5	5	5	25	1
15	8	8	8	21	21
16	25	25	25	5	5
17	3	21	21	2	2
18	21	3	3	9	9
19	6	9	9	3	3
20	9	6	6	6	22
21	7	7	7	22	6
22	12	12	12	7	12
23	10	10	22	12	10
24	22	22	10	10	7
25	11	11	11	11	11

tom, and loblolly showed only some slight changes.

To determine how much misallocation might actually result if the wrong rate was used, $50 million was allocated under the different interest rates in table 7. Projects through the rank of 11 were selected at 6 percent, and projects up to rank 9 were chosen under the other rates. The last projects were partially funded. If 8 percent is the correct rate, then the aggregate net present value of projects selected at that rate represents optimal allocation of funds. For comparability, the net present values of the projects selected under the other rates were recalculated using 8 percent. The consequence of suboptimal allocation may then be measured by comparing these values with the net present value of the projects selected at 8 percent. The results are surprising. A loss in total net present value occurred only at 6 percent. Even then, the decline in aggregate value was only 4 percent. Thus, using an interest rate slightly different from the proper one will result in only a small loss in aggregate net present value.

Parametric linear programming can also be used to perform other types of sensitivity analyses such as evaluating the effect of changes in stumpage prices or costs. For example, when stumpage prices and costs were varied 10 percent from their base levels, rankings changed little (table 8). Moreover, the changes are not nearly as extensive as those resulting from variation in interest rates.

Table 8.—*Ranking of type conversion opportunities with changes in costs and stumpage prices*

Rank	Costs		No change	Stumpage	
	+.10	−.10		+.10	−.10
1	23	23	23	23	23
2	19	19	19	19	19
3	13	13	13	13	13
4	16	16	16	16	16
5	17	17	17	17	17
6	14	14	14	14	14
7	18	4	4	4	18
8	4	24	24	24	4
9	24	1	18	1	15
10	15	18	1	18	24
11	1	20	15	20	1
12	20	15	20	15	20
13	2	2	2	2	2
14	5	5	5	5	5
15	8	8	8	8	8
16	25	25	25	25	25
17	3	3	3	3	3
18	21	21	21	21	21
19	6	6	6	6	6
20	9	9	9	9	9
21	7	7	7	7	7
22	12	12	12	12	12
23	10	10	10	10	10
24	22	22	22	22	22
25	11	11	11	11	11

CONCLUSIONS

The procedure has several applications. It can guide allocation of forestry investment funds to areas which offer the best economic potential. An example would be the distribution of annual FIP appropriations to the States. The ranking procedure can also be used by State agencies in allocating cost-sharing funds under programs such as FIP, or private firms might use it to guide their investment in type conversion. Finally, it can be used to explore the potential impact different levels of investment in type conversion might have on regional timber supplies. Hence,

it can serve as a tool in regional analysis of timber resources.

Ranking by parametric linear programming can also be extended to other geographic areas and to other stand improvement practices such as precommercial thinning or cull tree removal. Its application is limited only by the availability of appropriate models that can predict stand responses to cultural treatments. As such models are an important managerial tool, it is anticipated that research efforts to develop better growth and yield models will be greatly accelerated in the coming decade.

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U.S. Department of Agriculture
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Simulating Hydrologic Behavior on Ouachita Mountain Drainages

Thomas L. Rogerson

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Southern Forest Experiment Station
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Simulating Hydrologic Behavior on Ouachita Mountain Drainages

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Thinning, one of the most common forest management practices, profoundly affects the hydrologic components of the watershed. Determining the effect of thinning treatments experimentally would require years of study and a considerable expense. However, hydrologic simulation models can evaluate many different thinning levels in a few minutes of computer time. In addition, simulation models help to determine those parameters that have the greatest influence on the system and therefore should be measured as precisely as possible (Hill and others 1973).

Most hydrologic simulation models are complex, requiring many hydrologic variables and watershed parameters (Crawford and Linsley 1966, Holtan and Lopez 1971). The objective of this investigation was to develop a simple simulation model which would predict hydrologic behavior both before and after thinning on small experimental drainages of the Ouachita Mountains.

[1] The author is Research Forester, Southern Forest Experiment Station, Forest Service—USDA, Fayetteville, Arkansas.

DESCRIPTIONS OF DRAINAGES

Hydrologic and vegetation data from three small (1.28- to 1.63-acre) drainages were used for model development. The drainages have a northeast aspect and a slope of 15 percent. Soil types are Goldston, Herndon, and Alamance stony loams. The soils are shallow (2½ to 3 feet deep) and moderately permeable. Water storage capacity is low because of the thin solum. Parent material is predominately uplifted shale with some sandstone interbedding.

Annual precipitation on the drainages averaged 55.0 inches for the 1961-1973 period and ranged from 39.9 to 82.8 inches. Precipitation is distributed fairly evenly throughout the year. Almost all precipitation is rain, but light snow may fall one or two times each year. Runoff is intermittent and almost always ends within 24 hours of the precipitation event. Mean annual temperature is 62.1° F; the January mean is 42.3° and the July mean is 81.6°.

The initial vegetative cover consisted of a shortleaf pine (*Pinus elliottii* var *elliottii* Engelm.) overstory (105 ft²/acre) and a mixed hardwood understory (35 ft²/acre). In the spring of 1970, all vegetation was removed from one drainage; on another, the understory was removed, and the overstory was thinned to 60 ft²/acre of basal area; no thinning or clearing was done on the third drainage.

THE MODEL

The model was developed with data from the three drainages for calendar years 1968 and 1969. It was written in GPSS, an IBM discrete simulation language (IBM 1971, 1973), which

is available on IBM and Univac computers. The language offers great flexibility and allows model modifications without extensive reprogramming. The model was programmed for the IBM 370-155 computer at the University of Arkansas. It was classified as stochastic-empirical according to Clarke's (1973) definitions: it is stochastic in that the precipitation variable is random and has distributions in probability, and it is empirical in that it is based on observations and experimental data.

Hydrologic variables of precipitation, soil water in both the surface foot and profile (including the surface foot), and runoff, along with the watershed parameter of basal area, were used to estimate the equations, functions, and other parameters in the model.

The generalized hydrologic model can be written as:

$$PR = RO + ET + DS \pm \Delta SW$$

where

PR = precipitation
RO = runoff
ET = evapotranspiration
DS = deep seepage
Δ SW = change in soil water.

Input

The model can be run with two input modes. The first mode uses daily precipitation as input. Measured precipitation events for the period to be simulated are stored in a precipitation function by date (January 1 = 1 and December 31 = 365 or 366). A precipitation event is defined as a period of precipitation followed by at least 12 hours without precipitation. An event that occurs on 2 or more days is used as input on the day in which the major portion of the precipitation occurs. Days with no precipitation are entered as zeros. This mode was used in developing the model and in testing it against actual hydrologic data.

The second mode, which would be the one normally used, simulates precipitation from random numbers and parameters of precipitation event frequency and storm size derived from 13 years of precipitation data on these watersheds (Rogerson, unpublished data).

Other input needed are soil water deficits in the surface foot and in the profile—two variables which describe initial conditions in the model—and three parameters—basal area an maximum soil water deficits in the surface foo and in the profile. The time unit selected fo the simulation model was 1 day.

Precipitation—Throughfall Phase

The simulation begins each day by determin ing if precipitation occurs; if not, the simula tion proceeds to the evapotranspiration phas If precipitation occurs, storm size is either de termined from the measured values or simulate from parametric precipitation functions, de pending on the input mode selected. A through fall value is then calculated from a modifie form of Rogerson's (1967) equation:

$$THFAL = [.98\ PR - .00097\ (PR \times BA) - .0184]\ (DGR)$$

where

THFAL = throughfall in inches
PR = precipitation in inches
BA = basal area in ft^2/acre
DGR = dormant-growing season function.

The seasonal function (DGR) increases through fall by 5 percent during the dormant season. Thi value was derived from throughfall data (Law son 1975) collected on the experimental drain ages being simulated.

Runoff Phase

Several conditions determine whether runof occurs. First, if throughfall is less than or equa to 0.35 inch, no runoff occurs. Second, if through fall is greater than 0.35 inch but less than 1.0 inch, runoff cannot occur unless throughfall i greater than the soil water deficit in the sur face foot. Third, if throughfall is greater thar or equal to 1.00 inch, runoff can occur. An empirically derived equation containing the variables throughfall and soil water deficits in both the surface foot and profile determines the amount of runoff:

$$RO = .89498\ (THFAL) - .15\ (THFAL)\ (SWD_1) + (.25574/THFAL) + .05597\ (THFAL - SWD_1) - .03\ (THFAL - (SWD_1)\ (SWD_2) - .919$$

where

RO = runoff in area inches
THFAL = throughfall in inches
SWD_1 = soil water deficit in the surface foot in inches
SWD_p = soil water deficit in the profile in inches.

This phase also reduces the soil water deficits for the surface foot and profile by the throughfall amount if no runoff occurs or by the difference between throughfall and runoff if runoff has occurred.

Evapotranspiration Phase

Evapotranspiration for the surface foot and profile is simulated by multiplying factors derived from soil water deficit functions, a vegetation function, and a maximum transpiration-surface evaporation function, and then adding interception if precipitation has occurred. These factors must be greater than zero and less than or equal to one.

The soil water deficit functions (figs. 1 and 2) were developed from soil water data collected on the drainages with a neutron probe system. Maximum soil water deficits were 2.56 inches for the surface foot and 5.60 inches for the profile. As a general rule, the surface foot has 2.5 inches of available water, and each additional foot has 1.5 inches in the root zone or to bedrock (whichever is shallower). These values could be used in the model if soil water values were unknown. Soil water deficit/maximum soil water deficit ratios were used instead of maximum deficits to make the model adaptable to other areas. When these ratios are zero, the soil water factors are 0.727 for the surface foot and 1.000 for the profile. Thus, when both the surface foot and profile are saturated, nearly 73 percent of the transpiration-surface evaporation occurs in the surface foot. Both deficit factors remain near maximum until the ratios are greater than 0.5, and then they decrease rapidly.

The vegetation function (fig. 3) was derived from limited empirical findings from the three small watersheds with basal areas of 0, 60, and 140 ft². At 0 ft² the vegetation factor was 0.36

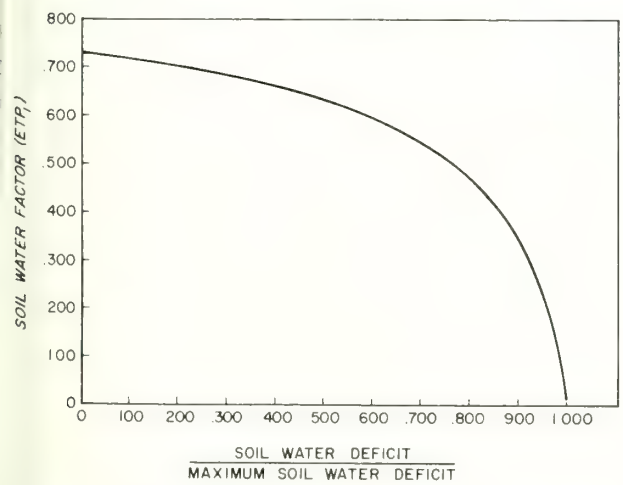

Figure 1.—*Relationship between soil water deficit ratio and soil water factor for the surface foot.*

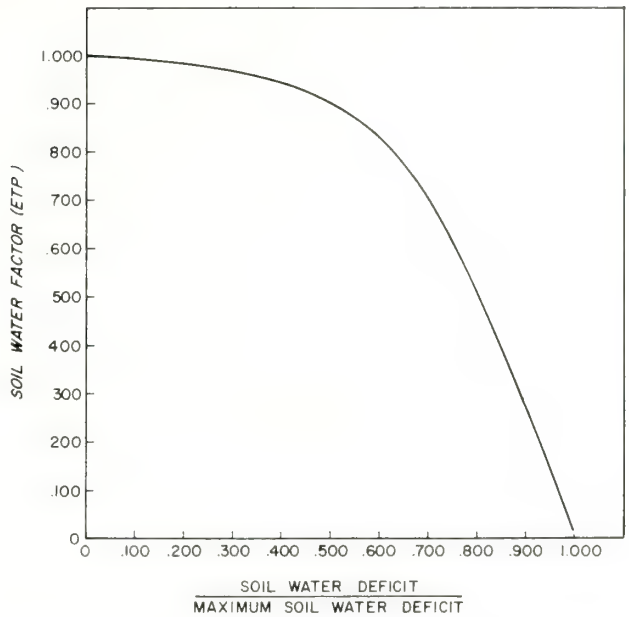

Figure 2.—*Relationship between soil water deficit ratio and soil water factor for the profile.*

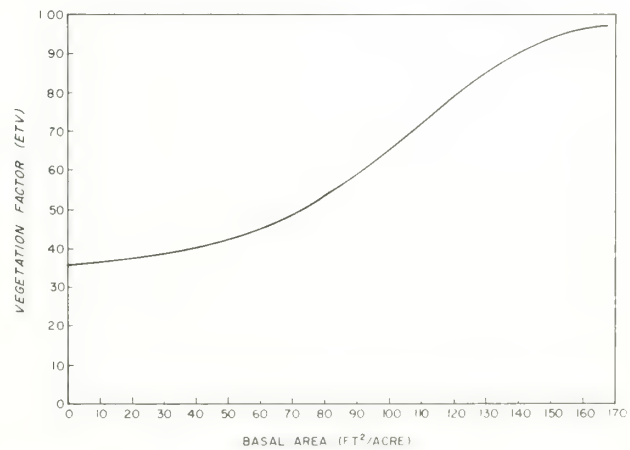

Figure 3.—*Vegetation factor as a function of watershed basal area.*

because of surface evaporation and transpiration by herbaceous species. Between 0 and 60 ft^2 the factor increased only slightly because the trees occupied only a portion of the site. As the basal area increased to 140 ft^2 and the site was more fully occupied, the vegetation factor rose rapidly; it was assumed to reach a maximum of 1.0 at 200 ft^2. The function's form was assumed to be similar to half of a normal curve. In a different situation and with more data, a different form might be more appropriate and could be easily substituted.

Maximum transpiration-surface evaporation was observed to range between 0.21 and 0.02 inch per day. Within this range, a function (fig. 4) was developed that is similar to average daily temperature and solar radiation curves. Additional investigation is needed to determine if this function could be empirically derived for various geographic locations.

Interception was computed as the difference between precipitation and throughfall.

The general equations for transpiration-surface evaporation and evapotranspiration are:

$$TE = (EPT)\ (ETV)\ (ETM)$$

and $$ET = TE + I$$

where

TE = transpiration-surface evaporation
EPT = soil water deficit function
ETV = vegetation function
ETM = transpiration-surface evaporation function
ET = evapotranspiration
I = interception.

If interception is greater than or equal to 0.3 inch, it was assumed that transpiration-evapo ration from the profile would be zero because o the high moisture content in the atmosphere an on the vegetation. In this case, profile evapo transpiration would equal interception. If trans piration-evaporation (TE) plus interception (I is greater than 0.35 inch, a new transpiratio value (TE_1) is recalculated to equal 0.35 inc minus interception. The same procedures ar used for surface foot simulations, except 0.3 inch is used instead of 0.35 inch. The values 0.3 and 0.30 inch were assumed for this simulatio but actual values for these parameters need t be developed.

In the final steps of the evapotranspiratio phase, the soil water deficits for the surface foo and profile are increased by their simulate daily transpiration-evaporation rates.

Deep Seepage Phase

Daily seepage values for both surface foot an profile are determined from soil water deficit seepage functions (figs. 5 and 6). These fun tions were derived empirically from soil wate deficit data during periods of low transpiratio

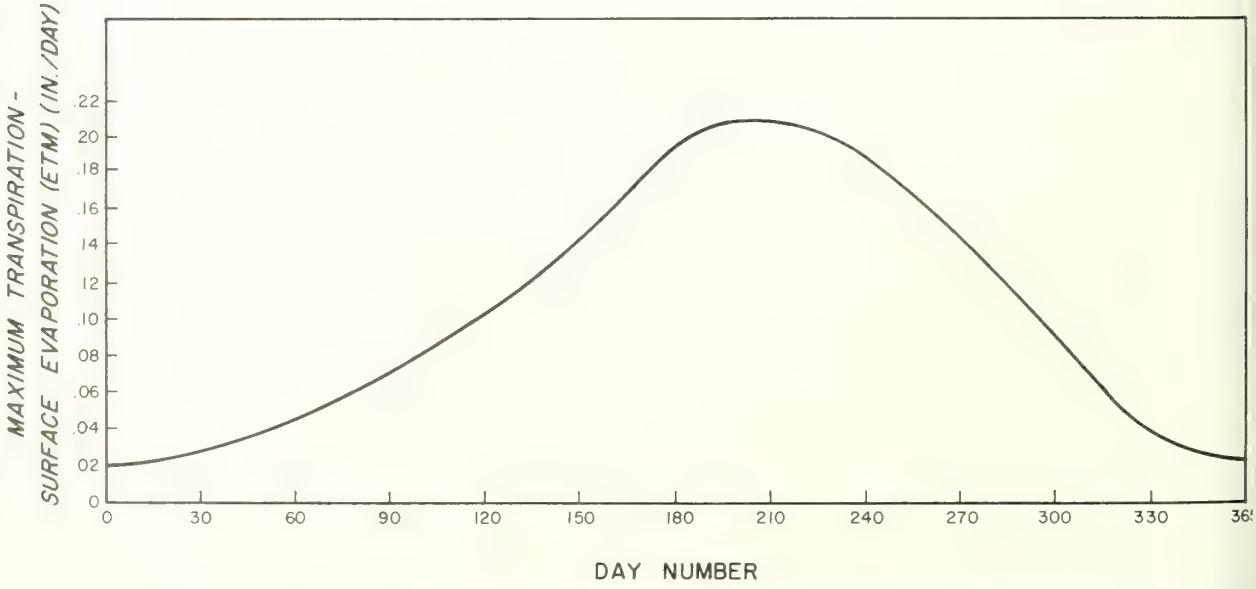

Figure 4.—*Relationship between date and maximum transpiration-surface evaporation.*

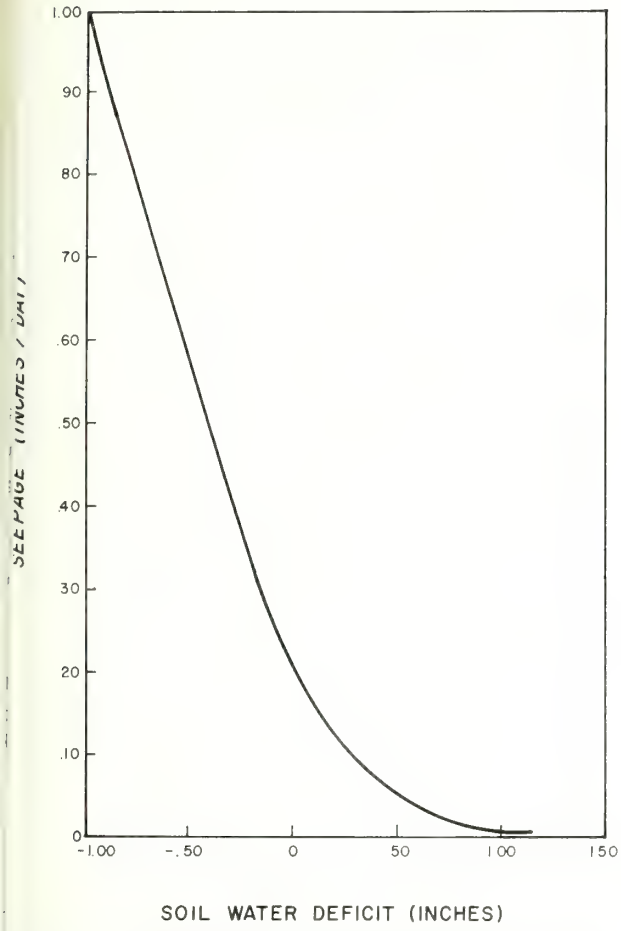

Figure 5.—*Relationship between soil water deficit in surface foot and seepage from surface foot.*

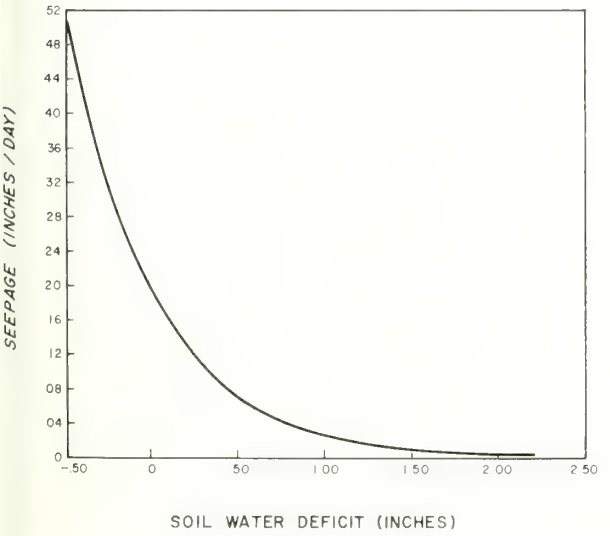

Figure 6.—*Relationship between soil water deficit in profile and seepage from profile.*

and no precipitation. When a soil water deficit was negative (soil water was greater than the maximum base value), seepage rates for both the surface foot and profile were about equal to the absolute value of the negative deficit. Thus, at the end of a day when this phenomenon occurred, the soil water deficit was approximately zero. At zero deficits, both surface foot and profile seepage rates were 0.20 inch per day. Seepage rates were nearly zero (but never reaching zero) when the soil water deficits approached 40 percent of their maximum values.

In the final steps of each day's simulation, the model updates the soil water deficit values for both the surface foot and profile by their respective seepage losses.

Output

Output from the model is easily varied and can be limited or expanded as necessary. Any variable in the simulation can be in the statistical output on a daily to annual basis. Variables may be tabulated in frequency distribution tables with the following output: sum of the variable, number of table entries, mean variable value, standard deviation, and the number of times the variable fell within each frequency class. Graphs can be plotted using any of the variables in the simulation. Additional output can be obtained by access to user-written FORTRAN subroutines.

Normal output for both input modes consists of (1) a graph of profile soil water deficits at biweekly intervals by 0.25-inch increments, (2) a daily precipitation and runoff summary which includes day number, precipitation, throughfall, runoff, and profile soil water deficits before the storm event for all dates on which precipitation occurs, and (3) a water budget summary by months which includes monthly and annual values for precipitation, runoff, evapotranspiration, deep seepage, and the change in soil water deficits.

If mode 2, simulated precipitation, is used, hydrologic behavior can be simulated for any number of years; but with mode 1 only 1 year can be simulated in each computer run. In mode 2, different precipitation event sequences can be obtained by changing random number multipliers. Using the same multipliers in successive runs will produce the same sequence of precipitation events. This duplication is useful if hydrologic differences between various levels of

basal area are being investigated. Caution must be exercised when thinning or clearcutting are simulated by modifying the vegetation factor of basal area because stand regrowth is not included in the model. After the vegetation factor has been modified, the simulation should not be continued for more than 3 years or erroneous values could result.

Two simulation runs, in mode 2, were made for 10-year periods. The same random number multipliers were used in both runs to produce the same sequence of precipitation events. In one run the parameter of basal area was 140 ft²/acre for the entire simulation, and in the other run it was reduced to 60 ft²/acre at the beginning of the eighth year. Soil water deficit graphs (fig. 7) and water budget summaries (table 1) for the eighth year are shown as an example of model output. There is little difference between the graphs for stands of 60 and 140 ft²/acre dur-

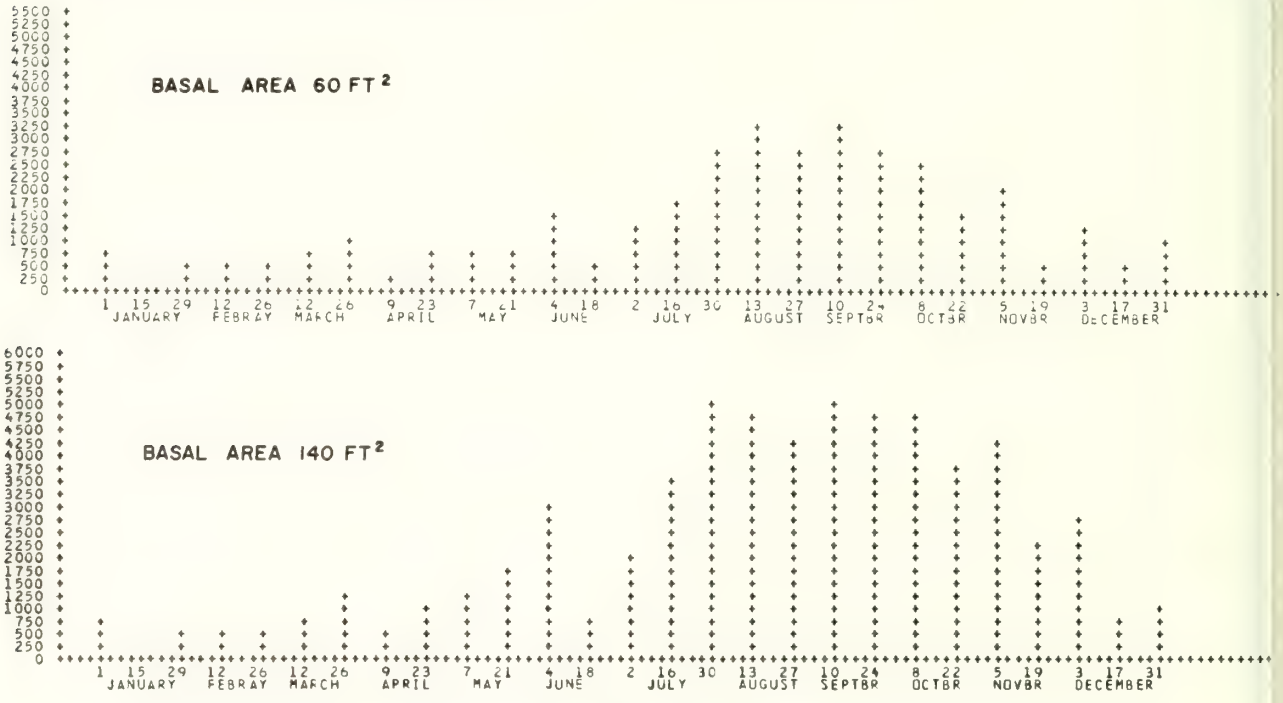

Figure 7.—*Comparison of biweekly profile soil water deficits for basal areas of 60 and 140 ft²/acre during the eighth year of simulation.*

Table 1.—*Comparison of simulated water budget summaries for basal areas of 60 and 140 ft²/acre during th eighth year of simulation*

Period	Precipitation	Runoff		Evapotranspiration		Deep seepage		Change in soil wate	
		60	140	60	140	60	140	60	140
		Inches							
January	8.59	1.53	1.17	0.86	1.89	6.12	5.50	0.09	0.03
February	9.03	3.35	2.78	.90	2.11	4.85	4.26	−.07	−.12
March	2.42	.08	.0	1.00	2.04	1.63	.99	−.29	−.60
April	5.20	.67	.39	1.66	3.27	2.63	1.26	.24	.28
May	2.43	.0	.0	2.01	3.84	1.17	.30	−.74	−1.70
June	10.39	4.20	2.44	3.25	5.75	2.72	1.25	.22	.95
July	1.52	.0	.0	3.01	4.62	.25	.07	−1.73	−3.17
August	2.88	.0	.0	2.76	2.37	.06	.06	.06	.45
September	3.38	.04	.0	2.37	2.89	.08	.06	.88	.43
October	2.20	.16	.0	1.73	2.10	.13	.06	.18	.04
November	3.15	.49	.02	.96	1.64	.98	.06	.72	1.43
December	5.60	2.49	1.19	.56	1.32	2.47	1.54	.08	1.55
Annual	56.81	13.01	7.99	21.07	33.85	23.08	15.42	−.34	−.45

ng the mid-December through early-May period when evapotranspiration is low. However, large differences occur during the late-May through early-December period when evapotranspiration is high and before soil water recharge is completed. Comparing the water budget summaries (table 1) reveals that runoff was 63 percent greater for the year and 102 percent greater for the June-December period on the 60 ft²/acre stand than on the 140 ft²/acre stand. Annual evapotranspiration was 38 percent less, and deep seepage was 50 percent more at the lower basal area.

MODEL ACCURACY

The goals at the onset of model development were to simulate annual runoff within 15 percent of the measured runoff 70 percent of the time and to simulate profile soil water deficits within 0.50 inch of the measured values 70 percent of the time. One can never exactly match simulated to recorded hydrologic values because recorded values contain measurement error (James 1972). Both measured runoff and soil water deficits probably contained errors of up to 10 percent of the actual values.

The model was tested by simulating the hydrologic system for 13 watershed-years when runoff and soil water deficits were measured. These years of record consisted of 5 years for a pine-hardwood watershed with a basal area of 140 ft²/acre, 4 years for a pine watershed thinned to 60 ft²/acre, and 4 years for a clearcut watershed. For 8 of the 13 watershed-years, or 62 percent of the time, the model simulated annual runoff within 15 percent of the measured values (table 2). This percentage was slightly less than the original goal but was considered acceptable because of the complexity of the system being modeled and the possibility of errors of up to 10 percent in the measured values.

The model predicted profile water deficits with slightly better accuracy than stated in my original goals. Thirty-eight percent of the simulated values were within 0.25 inch of the measured values and 73 percent were within 0.50 inch. Figure 8 shows the differences between measured and simulated profile soil water deficits for the three vegetative conditions during 1971. Simulated deficits for the thinned and clearcut watersheds were 0.25 to 0.75 inch greater than measured deficits throughout most of 1971. Also, several times during the year, measured deficits on the clearcut watershed were less than zero. Thus, the soil profiles were holding more water after treatment than before when the zero, or base line, deficits were determined. This increased capacity was attributed to increased organic matter in the form of decomposing roots from the cut vegetation. The increased water-holding capacity continued through 1972 and 1973. These changes in water-holding capacity were not observed on the uncut watershed.

Table 2.—*Annual precipitation, measured runoff and simulated runoff for the years tested*[1]

Year	Vegetation	Precipitation	Measured runoff	Simulated runoff
			Inches	
1967	Uncut	65.70	7.46	8.47
1970	Uncut	62.78	5.88	8.11
	Thinned		12.00	14.22
	Clearcut		19.51	16.56
1971	Uncut	46.76	4.31	4.56
	Thinned		7.48	7.63
	Clearcut		10.51	9.23
1972	Uncut	49.84	6.56	5.09
	Thinned		11.47	10.06
	Clearcut		11.95	12.36
1973	Uncut	82.71	20.79	14.58
	Thinned		27.22	23.99
	Clearcut		27.66	28.09

[1] Data for 1968 and 1969 were not used to test the model as these years were used to estimate parameters and develop the model.

Lawson (1967) reported that average interception on these same watersheds was 12.7 percent of the annual precipitation. Simulated interception for a 5-year period was 16.6 percent. The difference between the measured and simulated values was considered litter interception as this was not measured in Lawson's study. The 3.9 percent value for simulated litter interception is within the 2 to 5 percent range reported by Helvey and Patric (1965).

Evapotranspiration and deep seepage were not measured directly on the watersheds, but simulated evapotranspiration values were similar to those calculated by the Thornthwaite and Mather (1957) method. Simulated deep seepage values may seem to be too high to some observers, but part of the deep seepage on these small drainages would become runoff on larger watersheds. For example, the 32-acre watershed

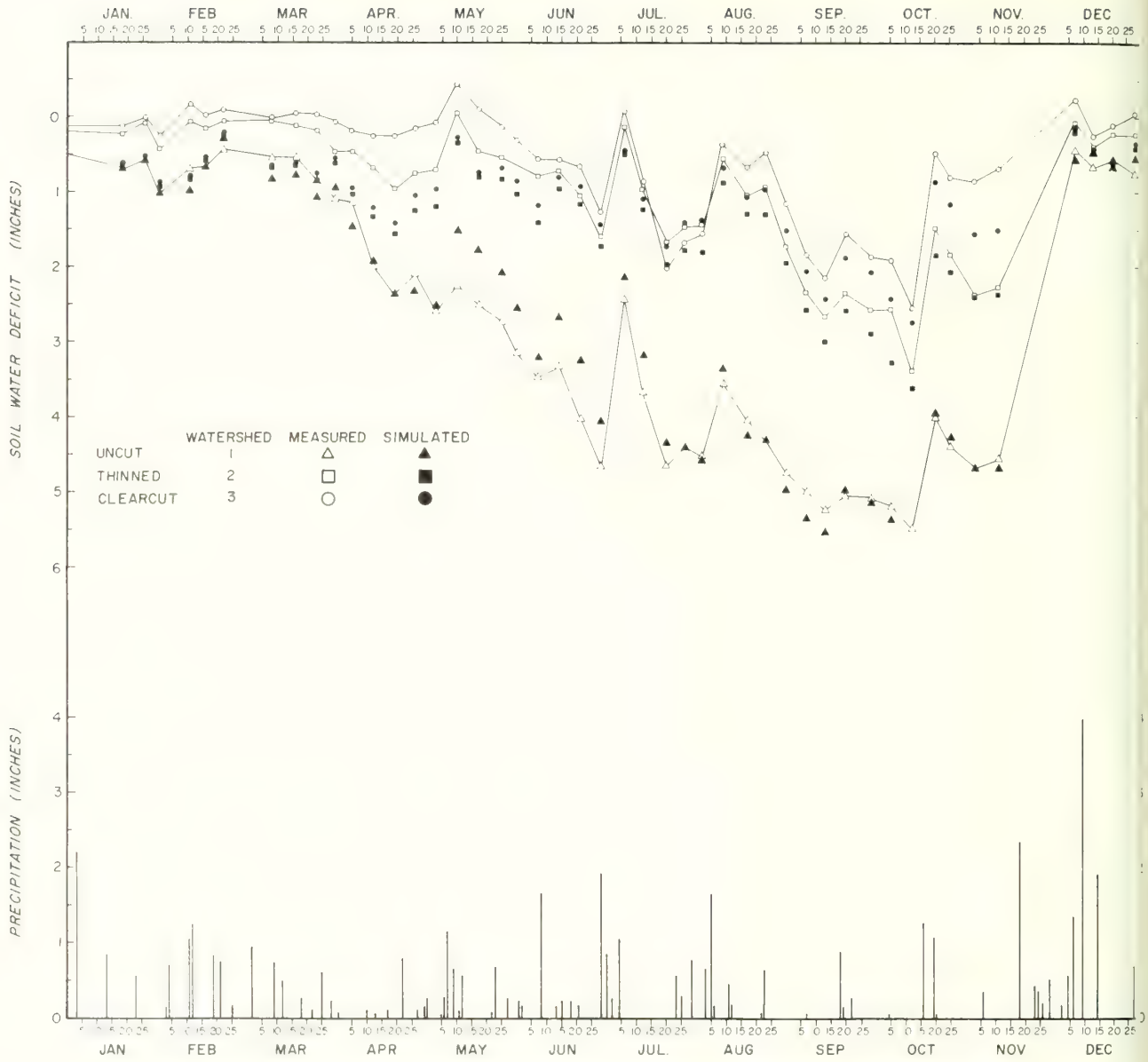

Figure 8.—*Measured and simulated profile soil water deficits under three vegetation conditions with daily precipitation for 1971.*

which includes the three small drainages in this study has had about twice as much runoff as the small drainages. Precipitation values for the small and large watersheds were the same, and evapotranspiration and changes in soil water were assumed to be similar since the vegetation and soils were the same. Therefore, differences in runoff between the small and large watersheds must be due to changes in the deep seepage component of the water balance.

If used cautiously, this simulation model should enable the watershed manager to better understand how altering the vegetative cover affects the hydrologic system and to predict th probable effects before initiating thinning. Th computer program is available from the autho

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Growth Following Initial Thinning Of Loblolly Pine Planted On A Cutover Site At Five Spacings

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Growth Following Initial Thinning of Loblolly Pine Planted On a Cutover Site At Five Spacings

D. P. Feduccia and W. F. Mann, Jr.[1]

Following first thinning, cubic-foot volume growth between ages 17 and 22 years for loblolly pine planted at various initial spacings was directly related to residual basal area per acre and site index. Diameter growth was inversely related to number of merchantable trees per acre after cutting at age 17. Regression equations are given to predict these parameters.

Additional keywords: *Pinus taeda* L., thinning, growth, diameter distributions.

In the winter of 1951-52, loblolly pines (*Pinus taeda* L.) were planted at five spacings on a broad array of site classes in southwest Louisiana. Measurements at age 17 years indicated that site quality and initial spacing had an important effect upon both volume and diameter growth (Mann and Dell 1971). Immediately thereafter, thinnings were made to a wide range of residual stocking levels in all spacings, and the stands were remeasured in 5 years to determine the effects of first thinnings on growth. Plots will be reinventoried and thinned every 5 years and will eventually provide more comprehensive information.

THE STUDY

Virgin longleaf pine (*Pinus palustris* Mill.) that was originally on the area was clearcut in the 1930's. The site was burned frequently by wildfire that kept scrub hardwoods in check. As a consequence, native grasses were predominant until pines were planted.

The 80-acre plantation consisted of four 20-acre blocks, each measuring 10 by 20 chains. Within each block, trees were planted by machine at approximate spacings of 6 by 6, 8 by 8, 9 by 9, 10 by 10, and 12 by 12 feet on strips 2 chains wide and 20 chains long. This resulted in four replications of each spacing. Overall, initial densities were fairly precise. The only seedbed preparation was burning the grass immediately before planting.

Soils on the area vary, but consist mostly of Caddo and Beauregard silt loams. They have slow internal drainage and in the winter the water table is near the surface. Topography is gently rolling, and surface drainage is fair, except on small interspersed flats.

Thinning plots. The long, narrow planting-spacing subblocks were divided into thinning plots 2 by 2 chains in size (0.4 acre), bypassing portions of strips with low survival or numerous volunteer longleaf pines. In all, 88 plots were established.

Site indices, ranging from 78 to 107 feet (age 50), were determined from heights of dominant and codominant trees on each plot and using Zahner's curves for poorly aerated soils in the Gulf Coastal Plain (1962). Site classes are not equally represented in all spacings, but there is a reasonable cross section in each (table 1).

Thinning levels, with residual densities of 60, 80, 100, and 120 square feet per acre (all ±3 square feet of assigned stocking), were installed at random within each spacing. Unthinned checks were also included. The unthinned category of the 10 by 10 and 12 by 12 spacings contains a large number of replicates; however, this is a temporary situation because some plots scheduled for treatment at age 17 with insufficient stocking for the prescribed thinning levels were considered as checks (table 1). Some unthinned plots had less than 120 square feet of basal area, which had insufficient stocking at age 17 for the designated level. Their growth was combined with that of thinned plots in the appropriate basal area class.

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Table 1.—*Number of plots in each planting-spacing-site category*

Basal area after thinning (ft^2)	Site index class	Initial spacing				
		6 by 6	8 by 8	9 by 9	10 by 10	12 by 12
	Feet	*Number*				
60	80	1	–	–	2	1
	90	2	4	2	–	2
	100	–	–	2	3	1
	110	1	–	–	–	1
80	80	2	2	–	2	–
	90	1	1	4	–	2
	100	–	1	–	2	1
100	80	1	–	–	–	–
	90	2	3	1	3	–
	100	–	–	2	–	–
	110	–	–	1	–	–
120	80	1	1	–	–	–
	90	2	3	1	–	–
	100	1	–	2	–	–
Unthinned	80	1	1	–	1	1
	90	2	2	3	5	3
	100	–	–	1	1	3

Residual basal areas at age 17 for the unthinned plots ranged from 73 square feet per acre on a poor site in the 12 by 12 spacing to 150 square feet per acre on a good site in the 6 by 6 spacing.

Thinning, in general, was from below. Large dominants were cut only when they were extremely rough or defective, when badly forked or diseased, and when their removal helped adjacent dominants.

Measurements were taken on the central 0.1 acre of each plot, including a complete tally of diameters to the nearest 0.1 inch. In addition, total height and height to succeeding 2-inch diameter taper steps were obtained on 8 to 17 volume sample trees. Sample trees were allotted to merchantable diameter classes (3.6 inches d.b.h. and larger) in proportion to the diameter distribution on the plot. Cubic-foot volume of each sample tree was calculated by height accumulation (Lohrey and Dell 1969). Total volume on individual plots was then computed by multiplying merchantable basal area by the volume/basal area ratio for sample trees on the plot.

Diameter inside bark to diameter outside bark ratios of 0.84 and 0.88 were used at age 17 and 22 years, respectively, to determine cubic-foot volumes inside bark. These ratios were determined from bark thickness measurements at breast height, at the midpoint of the merchantable stem, and at the 4-inch top on felled trees.

Growth data from all plots, thinned and unthinned, were combined for regression analyses. Various functions of site (S), residual basal area (B.A.), residual trees per acre (N), trees planted per acre (P), and interactions of these variables were examined using the REX—FORTRAN-4 system for combinatorial screening described by Grosenbaugh (1967).

Computing Volume Growth and Total Yield

Gross periodic annual volume growth (including mortality that was low) inside bark (P.A.V.G.) per acre from age 17 to 22 years was specified for trees in the 4-inch d.b.h. class and larger to a 4-inch top (d.o.b.) and to zero top. The best-fitting equations included only the functions, $1/S$ and $\log_{10}$B.A. The addition of residual number of trees at 17 and/or trees planted per acre did not reduce the relative mean squared residual below the two variables selected.

The two equations are:

P.A.V.G.$_1$ (inside bark per acre, trees in the 4-inch d.b.h. class and larger to zero top) =

$-299.92896 - 12060.644\ (1/S) + 347.60408\ (\log_{10}B.A.)$

$R^2 = 0.64$

$S_{y.x} = 31.1$

P.A.V.G.$_2$ (inside bark per acre, trees in the 4-inch d.b.h. class and larger to a 4-inch top d.o.b.) $= -274.55005 - 11130.018\ (1/S) + 322.34045\ (\log_{10}B.A.)$

$R^2 = 0.59$

$S_{y.x} = 32.6$

Both equations are significant at the 0.01 level. Values derived were within ±10 percent of the actual values on about three-fifths of the plots; about three-fourths of the predicted volumes were within ±15 percent.

To compute total yield to age 22 for various planting spacings and thinning density levels (table 2), production to age 17 was first determined. The equation for total net yield to age 17 for inside bark volumes per acre and trees in the 4-inch d.b.h. class and larger to a 4-inch top (d.o.b.) is: $-7936.1204 + 0.16682567\ (S^2) + 3314.4618\ (\log_{10}P) - 124.35858\ (P/S)$; $R^2 = 0.75$; $S_{y.x} = 195.1$. Periodic growth estimated by the equation for P.A.V.G.$_2$ was then added to the estimated unthinned yields to obtain total yield values at age 22.

Computing Diameter Growth

Periodic annual diameter growth (P.A.D.G.) of merchantable trees (3.6 inches d.b.h. and larger) and 50 largest trees per acre were subjected to regression analyses with the same independent variables as used for volume growth. The equations selected included the single variable, common logarithm of number of trees per acre (N) at the beginning of the period. Omission of site and basal area did not appreciably decrease the variation explained.

The equations are:

P.A.D.G.$_1$ (merchantable trees) $= 0.90371097 - 0.27580797\ (\log_{10}N)$

$R^2 = 0.84$

$S_{y.x} = 0.02$

P.A.D.G.$_2$ (50 largest per acre) $= 0.73335642 - 0.17909876\ (\log_{10}N)$

$R^2 = 0.53$

$S_{y.x} = 0.03$

Both equations are significant at the 0.01 level.

Table 2.—*Estimated total production (inside bark) per acre at age 22 for trees in the 4-inch d.b.h. class and larger to 4-inch top, d.o.b.*

Trees planted per acre (No.)	Residual basal area	Site index			
		80	90	100	110
	Ft²	*Cubic feet*			
300 (12 by 12)	60	1,671	2,086	2,504	2,939
	80	1,876	2,286	2,709	3,144
	100	2,031	2,441	2,864	3,299
440 (10 by 10)	60	2,004	2,444	2,882	3,332
	80	2,209	2,644	3,087	3,537
	100	2,364	2,799	3,242	3,692
540 (9 by 9)	60	2,144	2,600	3,052	3,513
	80	2,349	2,800	3,257	3,718
	100	2,504	2,955	3,412	3,873
	120	2,634	3,085	3,537	3,998
680 (8 by 8)	60	2,258	2,739	3,210	3,687
	80	2,463	2,939	3,415	3,892
	100	2,618	3,094	3,570	4,047
	120	2,748	3,224	3,695	4,172
	140	2,853	3,334	3,805	4,282
1,200 (6 by 6)	60	2,267	2,838	3,381	3,917
	80	2,472	3,038	3,586	4,122
	100	2,627	3,193	3,741	4,277
	120	2,757	3,323	3,866	4,402
	140	2,862	3,433	3,976	4,512

RESULTS

Volume Growth

Residual basal area influenced volume increment markedly (tables 3 and 4). Overall, each additional 10-square-foot increase in basal area increased growth by 9 to 24 cubic feet per acre annually, averaging about 15, with the largest differences at lower density levels. Thinning back to 120 square feet per acre resulted in about 1.6 times more volume growth than thinning to 60 square feet.

Table 3.—*Estimated gross periodic annual volume growth (inside bark) per acre from 17 to 22 years, for trees in the 4-inch d.b.h. class and larger to zero top*

Residual basal area (ft^2)	Site index			
	80	90	100	110
	Cubic feet			
60	167	184	198	209
70	191	207	221	232
80	211	228	241	252
90	229	245	259	270
100	245	261	275	286
110	259	276	289	300
120	272	289	302	313
130	284	301	314	325
140	295	312	325	336
150	306	322	336	347

Table 4.—*Estimated gross periodic annual volume growth (inside bark) per acre from 17 to 22 years, for trees in the 4-inch d.b.h. class and larger to 4-inch top, d.o.b.*

Residual basal area (ft^2)	Site index			
	80	90	100	110
	Cubic feet			
60	159	175	187	197
70	181	197	209	219
80	200	215	228	238
90	216	232	244	254
100	231	246	259	269
110	244	260	272	282
120	257	272	284	294
130	268	283	296	306
140	278	294	306	316
150	288	303	316	326

Site index also directly affected volume increment, with each 10-foot increase equivalent to 10 to 17 cubic feet of additional growth. A 10-foot difference in site index gave slightly more growth at low than high levels.

Periodic volume increment was excellent for the various sites and thinning intensities. It exceeded 150 cubic feet per acre yearly, even on plots thinned heavily on site 80. It was over 300 cubic feet per acre annually on unthinned plots on 110-foot sites.

On the other hand, planting spacing had no influence on volume growth after the first thinning, even though numbers of trees per acre and average tree sizes varied widely. The important factor in volume growth after thinning apparently was residual basal area and not number of trees.

Diameter Growth and Distributions

Predicted diameter growth of merchantable trees and 50 largest trees per acre were both inversely related to number of trees per acre 3.6 inches d.b.h. and larger after cutting at age 17 (fig. 1). High residual stocking had a greater influence on average diameter growth of merchantable trees than on the 50 largest trees per acre. Over the span of 200 to 800 residual trees per acre, differences in average diameter increment for the 5-year period were 0.85 inch for merchantable trees and 0.55 inch for the crop trees. A diameter growth rate in excess of 3 inches in 10 years was attained only by the 50 largest trees per acre in stands with no more than 250 trees per acre.

Unlike its effect on volume increment, planting spacing had an important influence on diameter growth after thinning. Since differences in diameter growth during the 5 years were relatively small between thinning treatments, initial spacing and site were still dominant as reported at age 17 (Mann and Dell 1971). The reason for continued importance of planting density is explained by the wider spacing having fewer trees than close ones at the same basal area levels. Too, live-crown ratios were greater with fewer trees. Of course, diameter growth is largely dependent on crown size.

Diameter distributions at age 22 were influenced most by planting density (tables 5-9). The widest spacing produced the greatest number of trees 12 inches and larger. With progressively lower diameter thresholds, closer spacings excelled. Considering trees 6 inches and larger, the 6 by 6 spacing had more trees per acre than all others.

Within any thinning treatment, poor sites had a greater number of total trees per acre than

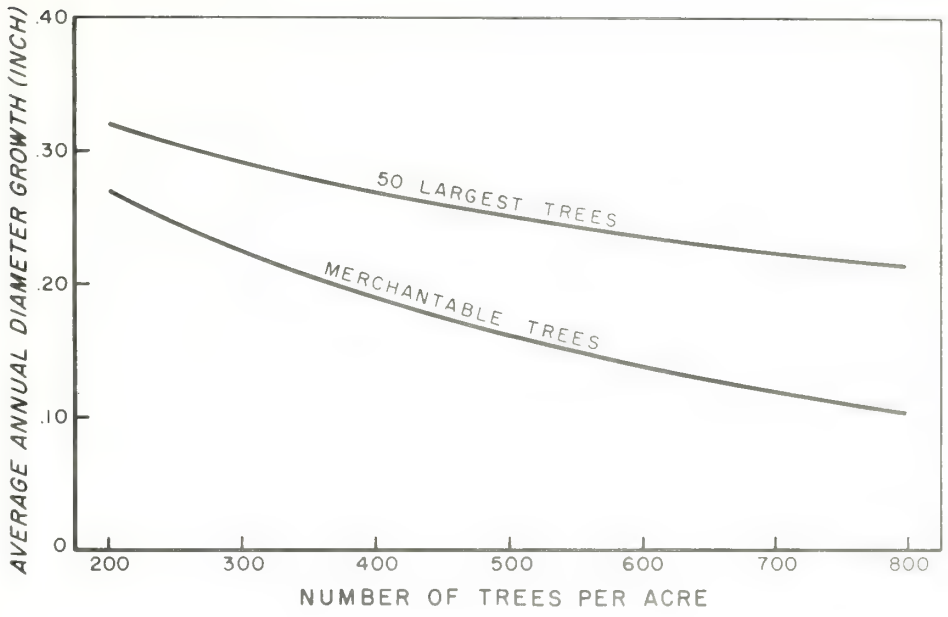

Figure 1.—
Effect of residual number of merchantable trees per acre at age 17 on periodic annual diameter growth of merchantable and 50 largest trees per acre, age 17 to 22 years for all sites combined.

good sites. This would be expected since competition in closely spaced plantations on the better sites begins at earlier ages, and to reach an assigned thinning-density level, fewer trees are retained on good sites than poor due to larger average diameter of the trees.

CONCLUSIONS

The overall trends found in this study are not new. It has been shown repeatedly that heavy thinnings stimulate diameter growth, but reduce volume growth. The importance of these data is the magnitude of differences.

Selection of a thinning regime is so important to the future productivity and development of a stand that it cannot be approached casually. A choice should be based on a thorough knowledge of growth responses to the various alternatives. This is illustrated by the tabulations below, which compare predicted diameter[2] and volume growth from 17 to 22 years for a broad span of residual basal areas at 17 years on 80- and 100-foot sites.

Basal area after thinning	5-year diameter growth: Merchantable trees	5-year diameter growth: 50 largest per acre	5-year volume[3] growth
Ft.[2]	Inches	Inches	Cords[4]
	Site 80		
60	1.3	1.6	10.4
80	1.0	1.4	13.1
100	.8	1.3	15.1
120	.7	1.2	16.8
Unthinned[5]	.5	1.1	18.2
	Site 100		
60	1.6	1.8	12.3
80	1.3	1.6	14.9
100	1.1	1.5	17.0
120	1.0	1.4	18.6
Unthinned[5]	.8	1.3	20.1

On site 80, a stand with 120 square feet of basal area per acre grew 16.8 cords or 62 percent more than one with 60 square feet. Offsetting this difference, diameter growth of merchantable trees was 0.6 inch greater with 60 than 120 square feet. Differences were about the same on the 100-foot site. Which treatment to select is an individual landowner decision. Of course, other comparisons are possible but intermediate treatments will merely give less stimulation of diameter growth than 60 square feet and less volume growth than the 120 square feet.

Are these differences in growth temporary

2 Diameter growth was predicted from the following regression equations:

P.A.D.G.$_3$ (Merchantable trees) = 1.27772799 − 23.137863 (1 S) − 0.4118408 ($\log_{10}$B.A.)

R^2 = 0.75; $S_{y.x}$ = 0.03

P.A.D.G.$_4$ (50 largest per acre) = 0.96682613 − 13.268876 (1 S) − 0.27256756 ($\log_{10}$B.A.)

R^2 = 0.48; $S_{y.x}$ = 0.03

3 Estimated value for trees in the [illegible] and larger, 4-inch top, d.o.b.

4 76.3 cubic feet per cord.

5 For residual densities of 140 square feet per acre.

Table 5.—*Diameter distribution of trees per acre at age 22 in the 6 by 6 spacing*

Basal area after thinning (ft^2)	Site index class	D.b.h. (inches)										
		< 4	4	5	6	7	8	9	10	11	12	Total
	Feet	*Number*										
60	80			10	39	59	107	29	20			264
	90	5	0	0	24	43	99	47	29	10		257
	110				10	10	39	29	59	29		176
80	80	34	25	5	87	87	112	34	15			399
	90		19	0	48	38	87	97	29	10		328
100	80	19	19	87	136	97	78	68	0	10		514
	90	5	39	68	68	127	97	49	24	5		482
120	80	29	86	153	125	124	134	48				699
	90	10	25	59	125	107	165	39	24	5		559
	100	10	48	87	116	106	106	48	19	0	10	550
Unthinned	80	59	188	168	158	137	98	29				837
	90	58	77	115	172	157	103	33	0	10		725

Table 6.—*Diameter distributions of trees per acre at age 22 in the 8 by 8 spacing*

Basal area after thinning (ft^2)	Site index class	D.b.h. class (inches)											
		< 4	4	5	6	7	8	9	10	11	12	13	Total
	Feet	*Number*											
60	90			5	3	8	16	54	61	34	13	3	5	202
80	80	11	15	42	37	135	36	51	10	10			347
	90	10	0	10	30	90	40	51	51	10	10		302
	100	11	0	0	11	11	73	53	52	42	11		264
100	90			10	38	68	110	86	34	10			356
120	80	10	0	102	111	112	111	71	31				548
	90	7	28	63	67	98	81	112	21	14			491
Unthinned	80	42	73	62	83	166	115	31	42				614
	90	5	19	29	99	113	99	75	45	10	10		504

Table 7.—*Diameter distributions of trees per acre at age 22 in the 9 by 9 spacing*

Basal area after thinning (ft^2)	Site index class	D.b.h. class (inches)												
		< 4	4	5	6	7	8	9	10	11	12	13	14	Total
	Feet	*Number*												
60	90	5	0	5	11	10	60	36	45	10	15			197
	100					10	30	30	59	20	5	0	10	164
80	90	2	3	7	32	34	23	67	48	33	3	2		254
100	90	10	20	10	81	110	91	81	10	10				423
	100		11	5	21	31	21	57	71	31	20			268
	110				10	10	48	39	87	20	10	20		244
120	90		11	11	33	67	100	122	11	11	11			377
	100			21	21	47	87	71	77	11	0	5	5	345
Unthinned	90	3	17	17	38	66	65	82	55	24	14			381
	100		10	30	30	81	40	81	71	30	10			383

Table 8.—*Diameter distributions of trees per acre at age 22 in the 10 by 10 spacing*

Basal area after thinning (ft^2)	Site index class	D.b.h. class (inches)													
		< 4	4	5	6	7	8	9	10	11	12	13	14	15	Total
	Feet	*Number*													
60	80	10	5	39	25	15	39	63	24	15					235
	100		6	3	0	9	21	44	28	40	9	6	3		169
80	80		9	9	38	42	66	61	61	14					300
	100					9	13	54	45	45	18	9	0	5	198
100	90	6	6	13	25	16	48	77	66	41	7				305
Unthinned	80	9	36	101	27	73	45	55	18						364
	90	6	6	25	24	47	47	79	43	30	17	2	0	2	328
	100		19	9	56	46	56	82	55	28	9				360

Table 9.—*Diameter distributions of trees per acre at age 22 in the 12 by 12 spacing*

Basal area after thining (ft^2)	Site index class	D.b.h. class (inches)														
		< 4	4	5	6	7	8	9	10	11	12	13	14	15	16	Total
	Feet	*Number*														
60	80			9	0	17	17	43	35	26	0	0	9			156
	90	5	0	0	0	0	19	19	54	39	9	0	9			154
	100							9	0	28	46	45				128
	110							9	36	9	18	44				116
80	90			5	0	14	14	32	41	45	37	5				193
	100						20	59	20	38	29	20				186
Unthinned	80	17	0	9	17	9	59	42	50	17	9	9				238
	90		3	0	16	19	26	45	38	76	10	7				240
	100			13	9	19	16	40	31	49	37	0	6	3	3	226

phenomena? Other, older studies have shown these trends will continue, except for the controls. Net growth in unthinned plantations will be less than in lightly thinned ones after about age 30, when suppression begins to cause mortality of merchantable sized trees (Mann 1952).

Before this stand was thinned, planting density and site had a strong influence on cubic-foot volume and average diameter (Mann and Dell 1971). These two factors also affected time of first cutting. A commercial thinning should be delayed until the stand fully occupies the growing space available and basal area is at least 100 square feet per acre. Stands planted at close spacings and/or growing on good sites have relatively high basal areas and can be thinned at an early age. However, cost of logging is apt to be high because of the large number of small stems that have to be handled.

Diameter and volume growth responses after the first thinning generally tend to be more erratic than after subsequent ones. This is due to variations in the stands before cutting. Responses will likely be slower in a stand cut to 80 square feet of basal area from 140 square feet than one cut to 80 from 100. Similarly, stands thinned to low basal areas take longer to fully respond to the added growing space than those cut to relatively high residual densities. Therefore, it can be anticipated that growth relations to thinning intensities will be better correlated in later cutting cycles.

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1976. Growth following initial thinning of loblolly pine planted on a cutover site at five spacings. South. For. Exp. Stn., New Orleans, La. 8 p. (USDA For. Serv., Res. Pap. SO-120)

Following first thinning, cubic-foot volume growth between ages 17 and 22 years for loblolly pine planted at various initial spacings was directly related to residual basal area per acre and site index. Diameter growth was inversely related to number of merchantable trees per acre after cutting at age 17. Regression equations are given to predict these parameters.

Additional keywords: *Pinus taeda* L., thinning, growth, diameter distributions.

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Maturation and Collection Of Yellow-Poplar Seeds In the Midsouth

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Forest Service
U.S. Department of Agriculture

1976

Maturation and Collection of Yellow-Poplar Seeds in the Midsouth

F. T. Bonner[1]

Yellow-poplar fruits are best collected in late October when their color changes from green to yellow-green or yellow. There were no other obvious physical or chemical changes indicating maturity. The seeds are physiologically mature as early as September 1, although high fruit moisture contents make special handling necessary if fruits are collected at this time. Fruits may be picked from logging slash as early as September after natural drying on the limbs.

Additional keywords: *Liriodendron tulipifera* L., physical and chemical changes, germination, artificial ripening, fruit and seed storage.

Yellow-poplar (*Liriodendron tulipifera* L.) is one of the most valuable hardwoods in the United States. It ranges from southern Ontario to the Gulf of Mexico and flowers from April to June (Renshaw and Doolittle 1965). Maturation occurs in September and October (Sargent 1965, Renshaw and Doolittle 1965). The cone-shaped fruit is $2\frac{1}{2}$ to 3 inches long and consists of about 80 winged carpels on a central axis. Each carpel contains one or two seeds, which usually abort because of ineffective pollination (Boyce and Kaeiser 1961); seeds from most trees average only about 10 percent full (Bonner and Russell 1973). The low percentage of filled seeds and the necessity to collect the fruits before they dry and shatter on the trees make collecting and processing yellow-poplar seeds expensive. This paper describes physical and chemical changes occurring during seed maturation, reports results obtained after artificial ripening treatments, and discusses how this knowledge might improve seed collection.

Methods and Materials

Seed-bearing trees were selected in Oktibbeha County, Mississippi, early in 1970. Beginning in July, 10 to 20 fruits were collected from four trees every 2 weeks until early November—just prior to natural

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breakup and seed dissemination. The same procedure was followed in 1971 and 1972 for three of the original trees and one substitute, which replaced a cut tree. The fruits were collected in the morning and transported to the laboratory in polyethylene bags.

Diameter, moisture content, fresh weight, and dry weight of 10 fruits from each sample tree were measured in 1970 and 1972; in 1971, these properties were measured for only five fruits per tree. Diameters were measured at the base. Dry weights were obtained after 24 hours at 105 C; moisture contents were expressed as percentages of fresh weights.

In 1971, the specific gravity of fruits from two of the sample trees was measured by water displacement on six dates from July to November. Fruits from one of the trees were split longitudinally, and the green carpels were separated by hand from wings and axes. The dewinged carpels (hereafter called seeds) were dried for 24 hours at 70°C and ground in a Wiley mill to pass a 20-mesh screen. The ground material was then analyzed for crude fat, soluble and insoluble carbohydrates, soluble and protein-nitrogen, phosphorus, calcium, and magnesium, according to procedures explained previously (Bonner 1972, 1974). All analyses were duplicated and repeated for agreement within 10 percent of the mean.

Germination was tested yearly for seeds from all of the sample trees. Immediately after collection, the fruits were air-dried in the laboratory and broken apart by hand. After the seeds were given moist stratification for either 60 or 90 days at 3°C, they were germinated on moist blotters under diurnally alternating temperatures of 20° and 30 C (I.S.T.A. 1966). Observations continued for either 45 or 60 days, according to the speed of germination; seeds with healthy emerging radicles and positive geotropism were considered germinated. At the end of the tests, ungerminated seeds were opened to obtain estimates of total filled seeds.

In 1971, artificial ripening was tested by procedures previously used for sweetgum (Bonner 1970). Five to eight fruits from each of two trees were given one of the following treatments:

(1) extraction immediately after collection

(2) storage in cloth bags at 3 C and 40 to 50 percent relative humidity (dry-cool)

(3) storage at 3 C in damp peat moss placed in polyethylene bags (moist-cool)

(4) storage in cloth bags in a building with temperatures of up to 30°C (dry-warm).

Collections were made on July 28, on September 7 and 21, and on October 5 and 19. Storage treatments began at the time of collection and lasted

until November, when the fruits were air-dried and broken apart by hand. After the carpels were dewinged and cleaned mechanically, germination tests were conducted.

The ripening treatment judged most successful was retested in 1973 by collecting green fruits from logging slash on August 28, September 10, and September 18. Half of the fruits were dried and extracted immediately, and the other half were artificially ripened until early December. The seeds were then extracted, dewinged, and upgraded (Bonner and Switzer 1971) before testing.

Results and Discussion

Physical Characteristics

Yellow-poplar fruits did not change markedly during the measurement period, and little yearly variation occurred (fig. 1). Fresh weight and moisture content decreased slightly; dry weight was almost constant. Specific gravity declined steadily from 0.86 to 0.68 as moisture content fell and was as low as 0.47 for very dry fruits immediately before opening in early November. Mean diameter, which did not change over the 3-year test period, averaged 18 mm at the base from July through October. These results indicate that the fruits are fully grown by July 1, when they contain sufficient food stores for the seeds.

Fruit exteriors remained bright green in July and August but were fading by late September-early October. By late October, the ripest fruits were yellow or light brown although the green color was still visible on many. The completely brown color normally associated with mature yellow-poplar seeds was not prevalent until the dried fruits began to open on the trees in November. Seed collections should therefore be started well before fruit exteriors turn completely brown.

Chemical Characteristics

Seasonal trends in seed chemical components were of little value in assessing maturation. Chemical changes were difficult to measure, partially because of the presence of large amounts of tissue without embryos. This problem occurred previously with sycamore (Bonner 1972), which also has a low percentage of filled seeds. Accurate chemical indices of seed maturity are therefore useful for filled seeds only; however, separation of full from empty seeds in green fruit is not practical.

Crude fat concentration increased somewhat in early fall, but the total amount in the seeds—never above 3 percent of the dry weight—was too low to be significant (fig. 2). Protein-nitrogen was stable at about 0.5 percent, and soluble nitrogen decreased slightly (from 0.3 to 0.1 percent) with maturity.

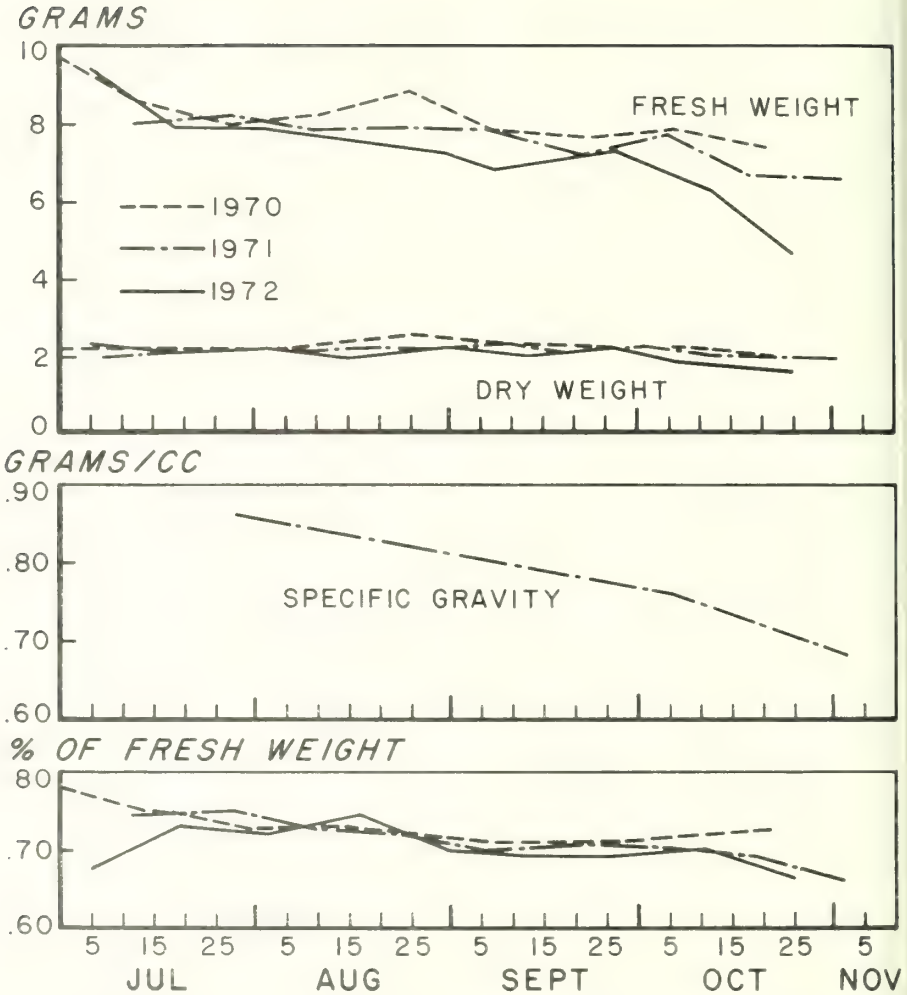

Figure 1.—*Seasonal changes in fresh weight, dry weight, specific gravity, and moisture content of yellow-poplar fruits. Specific gravity data are for two trees only in 1971.*

Although carbohydrates were the most important storage food for these seeds, no perceptible seasonal buildup occurred (fig. 2). Soluble carbohydrate concentration decreased throughout the season (from 11 to about 3 percent), but insoluble carbohydrates fluctuated widely between 15 and 20 percent. At maturity, total carbohydrate content was about 20 percent of the seed dry weight.

Phosphorus content remained relatively steady throughout the season, ranging from 0.12 to 0.18 percent. Magnesium measured 0.18 percent in July and 0.17 percent in November. Calcium content of the seeds more than doubled from 0.14 percent in July to 0.36 percent in November.

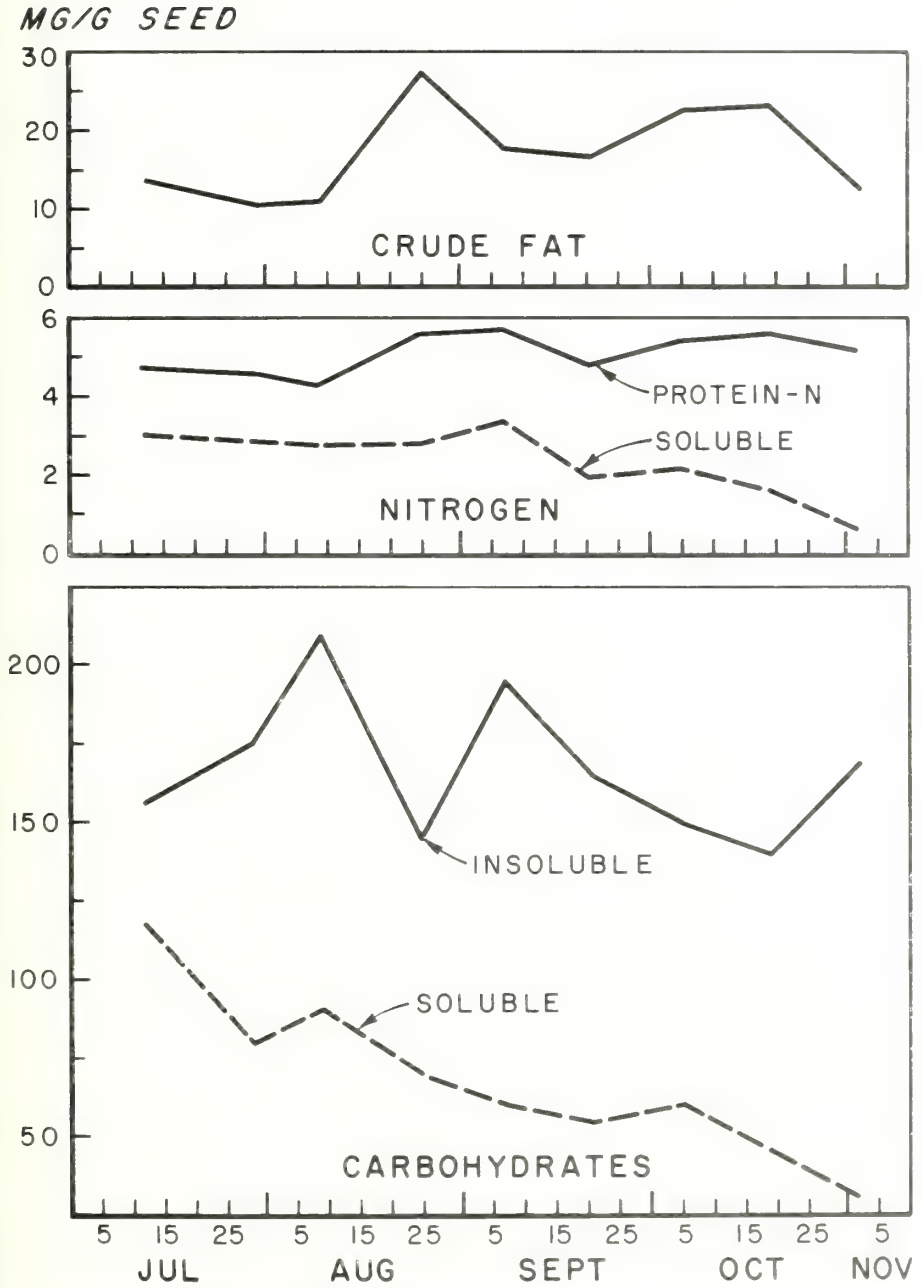

Figure 2.—*Seasonal changes in crude fat, nitrogen, and carbohydrate fractions of yellow-poplar seeds*

Germination and Artificial Ripening

Germination data indicated that the seeds were physiologically mature by late September or early October (table 1). When judged according to total seeds, germination capacities were quite low, never averaging more than 5.2 percent; however, germination percentages of filled seeds were sometimes as high as 100 percent (table 1). In 1971, all of the artificial ripening treatments produced good, normal germination (table 2). The germinants in the moist-cool treatment

Table 1.—*Germination percentages of yellow-poplar seeds collected at various times*

Collection date	Number of sample trees	Germination capacity	
		Total seeds	Filled seeds
		Percent	
1970			
Sept. 8	1	5.0	100
23	4	4.8	100
Oct. 6	4	5.2	97.0
21	4	2.3	92.8
1971			
Sept. 8	1	1.5	42.1
21	4	2.5	(1)
Oct. 5	5	4.2	79.8
19	5	2.3	94.5
Nov. 2	5	3.9	100

[1] Ungerminated filled seeds were not counted on these samples.

Table 2.—*Germination percentages of seeds from fruits after artificial ripening treatments*

Collection date (1971)	Storage treatment			
	None (extracted immediately after collection)	Moist-cool	Dry-cool	Dry-warm
	Percent			
	Tree A			
July 28	0	4.7 (55.9)[1]	0	0.5 (18.2)
Sept. 7	0.5 (22.2)[1]	7.0 (100)	3.4 (46.9)	0
Sept. 21	.2 (10.0)	3.2 (100)	2.5 (38.5)	1.7 (100)
Oct. 5	.2 (3.6)	5.2 (58.8)	5.3 (100)	0.8 (11.5)
Oct. 19	1.9 (50.0)	7.1 (78.6)	1.3 (100)	2.9 (100)
	Tree B			
July 28	0	0	0	0
Sept. 7	1.5 (42.1)[1]	9.3 (100)	0	5.4 (100)
Sept. 21	6.1 (44.1)	3.7 (39.1)	1.5 (27.3)	3.5 (100)
Oct. 5	1.2 (23.3)	13.2 (88.3)	3.4 (100)	5.4 (100)
Oct. 19	5.2 (72.7)	3.9 (66.7)	3.5 (66.7)	2.3 (100)

[1] Percentages in parentheses are for filled seeds only.

appeared slightly more vigorous than the others. For both sample trees, moist-cool storage after the September and early October collections was usually better than immediate extraction. Seeds from the two sample trees appeared to differ; ripening of fruits picked on July 28 was successful for Tree A but not for Tree B.

In 1973, when the moist-cool ripening treatment was used on half-bushel lots of fruits picked from logging slash, seeds extracted at the time of collection germinated just as well or better than those that were artificially ripened (table 3). The only benefit from artificial ripening was that germination began 4 to 10 days earlier for stored seeds than for those that were extracted immediately.

Table 3.—*Germination capacity of seeds from artificially ripened (moist-cool storage) and upgraded lots*

Collection date (1973)	Extracted immediately after collection	Extracted after moist-cool storage
	— — — — — — — — *Percent* — — — — — — — —	
Aug. 28	39.0 (97.5)[1]	19.0 (82.6)[1]
Sept. 10	14.0 (66.7)	7.0 (50.0)
Sept. 18	17.0 (89.5)	21.0 (95.5)
Mean	23.3 (87.5)	15.7 (79.7)

[1] Percentages in parentheses are for filled seeds only.

Fruits from logging slash may be partially ripened by drying after cutting, thereby lessening the effectiveness of the ripening treatment. Lengthening the collection season might be accomplished by picking fruits from logging tops felled for as long as 4 weeks before natural dispersal (Anonymous 1940). This procedure would be useful to collectors having access to logged trees in August, if they are willing to care for the cones.

Guidelines For Collection

Although the guidelines reported here are based on measurements of trees in central Mississippi, they should be applicable throughout the Midsouth:

(1) Collection of intact fruits from trees should normally not begin until the last half of October.

(2) The best index of maturity is the color change of fruit exteriors from bright green to yellow-green or yellow, a change normally occurring in late October in central Mississippi.

(3) The collection season can be extended by gathering fruits after September 1, when the seeds are apparently physiologically ma-

ture. However, special handling may be required because of the high fruit moisture content (about 70 percent). After collection, fruits should be spread in a thin layer for drying and must never be allowed to overheat.

(4) Fruits may also be picked as early as September from logging slash. Although precautions due to high fruit moisture still apply, natural drying on the limb partially alleviates this problem.

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Bonner, F. T.

1976. Maturation and collection of yellow-poplar seeds in the Midsouth. South. For. Exp. Stn., New Orleans, La. 8 p. (USDA For. Serv. Res. Pap. SO-121)

Yellow-poplar fruits are best collected in late October when their color changes from green to yellow-green or yellow. There were no other obvious physical or chemical changes indicating maturity. The seeds are physiologically mature as early as September 1, although high fruit moisture contents make special handling necessary if fruits are collected at this time. Fruits may be picked from logging slash as early as September after natural drying on the limbs.

Additional keywords: *Liriodendron tulipifera* L., physical and chemical changes, germination, artificial ripening, fruit and seed storage.

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Cone and Seed Maturation of Southern Pines

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Southern Forest Experiment Station
Forest Service
U.S. Department of Agriculture

1976

Cone and Seed Maturation of Southern Pines

James P. Barnett[1]

For immature loblolly (Pinus taeda *L.*) *and slash* (P. elliottii *Engelm.*) *pine cones collected over a range of dates and stored for 3 to 5 weeks, seed yields were reduced but adequate, and germinability increased with increasing cone storage periods. If slightly reduced yields and viability are acceptable, loblolly and slash cone collections can begin 2 to 3 weeks before maturity if the cones are stored before processing. Longleaf* (P. palustris *Mill.*) *pine cones should be collected only when mature, as storage decreased germination of seeds from immature cones. Biochemical analyses to determine reducing sugar contents of seeds and x-rays to determine if the seedcoats are filled show promise as seed maturity indices.*

Additional keywords: *Pinus palustris, P. taeda, P. elliottii*, germination, biochemical composition, cone specific gravity, cone storage.

The demand for southern pine seeds is increasing rapidly in response to escalated forest regeneration programs. Traditionally, cone collections are made within a 2- to 3-week period after specific gravity drops below 0.89, the normal index of maturity (Wakeley 1954). Because of limited labor available for collecting cones, this period is too short to allow collection of enough cones to provide an adequate seed supply. If the period could be extended by 2 to 3 weeks, the number of seeds collected might easily be doubled.

An extended collection period is reportedly possible if slightly immature cones are stored prior to kilning (Bevege 1965, Waldrip 1970, McLemore 1975). However, maturity indices that reflect the ripeness of seeds as well as cones after storage have not been developed. The tests reported here were installed to determine maturation of southern pine cones and seeds collected on different dates and stored for various periods. X-rays and biochemical analyses were evaluated as possible indices of seed maturity.

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METHODS

Collection, Storage, and Processing

Cone and seed maturity were tested for loblolly (*Pinus taeda* L.), longleaf (*P. palustris* Mill.), and slash (*P. elliottii* Engelm.) pines from natural stands in the Palustris Experimental Forest in central Louisiana. For each of the three species, 24 cones were collected from each of four trees selected for their large seed crops. To provide a range of seed maturity, collections were made weekly from September 15 to October 13, 1969, for loblolly and longleaf, and from July 12 to September 22, 1971, for slash pine. Since the earliest (September 15) collection of loblolly seed proved mature, collections for loblolly and longleaf were begun 5 weeks earlier the following year and were repeated biweekly (August 10 to October 17, 1970). The 24 cones from each tree were divided into four equal groups for tests of cone and seed maturity. One group was tested for specific gravity and moisture content immediately after collection, and the other three groups received one of three storage treatments to determine if the cones would ripen independently of the tree. The cones were stored in open paper bags in an unheated building for 1, 3, or 5 weeks prior to processing. As each of the storage treatments was completed, the cones were opened by drying for 3 days in a gas-fired kiln (38° C). Cone maturity was determined by seed yield. Casehardened cones were considered immature, and their seeds were obtained by opening the cones mechanically. Seeds from the 1- and 3-week storage treatments were immediately placed in a refrigerator (1° C) to slow development. At the end of the 5-week storage period seeds from all of the storage treatments were used for germination trials and biochemical analyses. After all of the seeds were cleaned, filled ones were separated from empties by liquid separation—loblolly in water, longleaf in *n*-pentane, and slash in 1:1 ethanol and water.

Germination tests.—Germination tests were made under standard laboratory conditions. Because loblolly seeds are dormant, they were stratified for 28 days at 1°C on a sand-peat medium. Longleaf and slash were left unstratified. One hundred seeds were sown in factorial combination for each tree, collection date, and storage treatment.

Biochemical analyses.—Because of species differences in size, 50 longleaf, 100 loblolly, and 75 slash pine seeds for each tree-treatment-date combination were freeze-dried and stored at 1° C. They were then analyzed for lipids according to Ching's method (1963), for reducing sugars by a modified Somogyi method (Nelson 1944), and for protein or insoluble nitrogen and total soluble sugars by methods reported previously (Barnett and Naylor 1970).

X-rays.—Before processing, the slash pine seeds to be used for the biochemical analyses were x-rayed to determine how much of the seed cavity was filled by the embryo and megagametophyte.

Analyses.—For each species, analyses of variance were conducted to determine differences in seed yields, germination, and biochemical properties (0.05 level of significance).

RESULTS AND DISCUSSION

Loblolly

Morphological characteristics and viability.—In both collection years, the specific gravity of loblolly cones averaged approximately 0.89 near October 1, when cone moisture contents were about 110 to 120 percent.

In 1969, the average number of seeds released per cone tended to increase with each subsequent collection date and with increasing lengths of cone storage (table 1). Cones from the early collections appeared to benefit most from a long storage period, as evidenced by improved yields with longer storage. Cones collected as early as September 15, when the specific gravity was 0.99, and stored for 5 weeks yielded 38 seeds per cone, which compared favorably with the 17-seed-per-cone average obtained for the final collection after 1 week of storage, when specific gravity averaged 0.80. For cones collected on September 29, when specific gravity was 0.88, the average yield per cone after 1 week of storage was only one seed, but yields increased appreciably both after longer storage and with subsequent collections.

The fact that germination was not affected by either date of collection or storage treatment shows that collections were not begun early enough to allow observations of seed development. It is obvious that seed maturity of loblolly seeds occurs several weeks before cones are ripe enough to open fully. These results were confirmed by the 1970 loblolly tests, in which collections commenced 5 weeks earlier than in 1969 and storage was omitted. In 1970, seed yields were nil through September 21 but were satisfactory thereafter. Germination was 58 percent for the seeds collected on September 7, 79 percent for September 21, and 96 percent for October 5. No viable seeds were obtained from the August collections.

Loblolly pine cone collections normaily begin about October 1, when specific gravity—the conventional index of maturity—is about 0.89. Results in this study indicate that collections can commence 2 to 3 weeks earlier if some reductions in yield and viability are acceptable and if the cones are stored 3 to 5 weeks before processing.

Biochemical analyses.—Although there were significant differences among individual trees in contents of total sugars, lipids, and protein-nitrogen, there were no differences caused by collection date or storage treatments (table 1). The only notable biochemical changes measured were levels of reducing sugars, which dropped steadily with

Table 1.—*Characteristics of loblolly pine cones and seeds after various collection dates and storage periods*

Collection date (1969) and storage period (weeks)	Cone specific gravity	Cone moisture content	Seed yield per cone	Germination	Reducing sugars	Total sugars	Lipids	Insoluble nitrogen
		Percent	*Number*		*Percent*			
September 15	0.99	129.3	...	...	0.53	2.4	16.7	2.4
1			0	96	.04	1.6	17.0	2.5
3			14	98	.03	1.7	17.2	2.2
5			38	98	.02	1.5	16.0	2.6
Average			17	97	.16	1.8	16.7	2.4
September 22	.93	119.9	...	...	.40	1.8	17.8	2.8
1			22	95	.05	1.5	17.4	2.2
3			27	97	.03	1.5	18.2	2.3
5			28	98	.03	1.6	17.4	2.4
Average			26	97	.13	1.6	17.7	2.4
September 29	.88	112.1	...	...	.14	1.7	18.3	2.4
1			1	98	.03	2.5	18.1	1.7
3			40	98	.02	2.8	18.3	2.3
5			65	98	.03	2.8	19.3	2.7
Average			35	98	.06	2.4	18.5	2.3
October 6	.82	103.6	...	...	.06	3.1	19.3	1.7
1			35	98	.02	3.0	19.1	1.6
3			45	98	.04	2.6	17.7	1.6
5			38	98	.02	2.3	18.0	2.2
Average			39	98	.04	2.8	18.5	1.8
October 13	.80	84.3	...	...	.02	2.7	18.3	2.2
1			47	99	.01	2.8	18.7	2.2
3			52	99	.02	3.3	18.7	2.2
5			44	99	.02	2.8	18.2	2.3
Average			48	99	.02	2.9	18.5	2.2

each successive collection date. The percentage of reducing sugars after cone storage was very low regardless of the date of collection, an indication that reducing sugars were converted to other products during the first week of storage. Reducing sugar content of seeds may therefore indicate cone maturity. In this study, cone maturity (specific gravity of 0.88) occurred when the reducing sugar content of the seeds was 0.14 percent.

The extension of the collection period in 1970 resulted in a much greater range of values in all the constituents measured; however, at a given date, all levels compared closely with those obtained the previous year.

Longleaf

Morphological characteristics and viability.—Differences between cone collections made in 1969 and 1970 showed that longleaf cones sometimes ripen considerably later than loblolly. Longleaf cones collected in 1969 reached maturity as indicated by a specific gravity of 0.89 on September 29; but in 1970 ripeness did not occur until October 17. Differences in individual trees may explain some of the variation. Cone moisture contents of longleaf varied slightly from that of loblolly; specific gravity was 0.89 when moisture content was about 140 percent.

Like loblolly, yields of longleaf seeds increased both from early to late collections and with increasing cone storage periods (table 2). Unlike loblolly, late collections of longleaf showed increased yields after storage, even when specific gravities were as low as 0.80. The highest yields were obtained with cones stored 3 to 5 weeks when initial specific gravities were 0.89 or below. Yields for cones collected earliest (September 15) and held for 5 weeks were only about half those obtained from the later collections.

Viability increased with each successive collection date; however, germination of the seeds from immature cones decreased with the length of cone storage; only seeds from the last collection retained high viability over the 5-week storage period.

These results indicate that longleaf cones should be collected only when mature; however, a storage period longer than 8 weeks would diminish seed storability (McLemore 1961).

The 1970 tests confirmed that cones collected and processed before specific gravity is less than 0.90 fail to open and release seed. Seeds were obtained only from the final cone collection (October 19); germination was 93 percent.

Biochemical analyses.—Percentages of reducing sugars for unstored cones in the 1969 collections ranged from 0.64 to 0.19 from the early to the late collection (table 2). Except for the latest (October 13) collection, the values for each collection date dropped markedly during

Table 2.—*Characteristics of longleaf pine cones and seeds after various collection dates and storage periods*

Collection date (1969) and storage period (weeks)	Cone specific gravity	Cone moisture content	Seed yield per cone	Germination	Reducing sugars	Total sugars	Lipids	Insoluble nitrogen
		Percent	*Number*		*Percent*			
September 15	0.98	156.2	...	...	0.64	4.7	29.2	4.0
1			0	64	.22	2.6	29.0	4.4
3			4	31	.17	1.3	26.2	3.1
5			33	20	.18	1.8	24.4	3.4
Average			13	38	.30	2.6	27.2	3.7
September 22	.93	154.0	...	...	.56	3.8	27.4	3.8
1			9	71	.21	2.2	27.3	3.7
3			20	43	.04	2.0	26.4	3.8
5			37	43	.18	3.5	28.7	4.2
Average			22	52	.25	2.9	27.4	3.9
September 29	.89	136.3	...	...	.46	4.4	27.8	3.8
1			0	73	.23	2.6	28.5	3.8
3			39	74	.12	2.9	28.5	3.7
5			59	60	.07	3.4	26.3	3.6
Average			33	69	.22	3.3	27.8	3.7
October 6	.85	128.5	...	...	.42	3.2	29.5	3.6
1			5	81	.11	2.3	30.4	4.0
3			54	74	.14	2.9	26.9	3.8
5			47	60	.20	3.3	25.9	3.8
Average			35	72	.22	2.9	28.2	3.8
October 13	.80	126.7	...	...	.19	2.8	29.4	3.7
1			23	91	.18	2.6	30.1	4.0
3			46	90	.12	3.7	27.4	4.0
5			56	91	.10	3.4	25.6	4.0
Average			41	91	.15	3.1	28.1	3.9

the first week of storage, after which the decreases were smaller.

Values for total sugar also varied with collection date and cone storage period but followed the trends observed for loblolly pine seeds. Although sugars in seeds from unstored cones decreased from 4.7 percent for the earliest collection to 2.8 percent for the latest, total sugar contents of seeds from stored cones tended to increase with length of storage.

Although lipid contents were not affected by collection date, levels decreased with increasing lengths of cone storage (table 2). Insoluble nitrogen was not affected by either collection date or storage period.

Slash

Morphological characteristics and viability.—Slash pine cone collections typically begin in early September; the present tests confirm that maturity occurs before September 15. Cone moisture contents were about 135 to 140 percent when specific gravity was 0.89.

Cone collections began about 8 weeks prior to maturity. Like loblolly and longleaf pine slash pine seed yields increased with each subsequent collection date and with longer cone storage periods. Acceptable yields were obtained when cones were collected in late August, provided the cones were held 3 or 5 weeks prior to processing (table 3). When cones were held for 5 weeks, seed yields from the August 23 collection (specific gravity 0.99) were 70 per cone compared to 85 for cones that were picked on September 22 (specific gravity 0.81).

Germination levels were never high. Best germination (83 percent) was for seeds from cones collected on September 22 and held 5 weeks. No seeds from cones picked in July germinated, even after 5 weeks of storage, and viability was low for seeds from the August collections regardless of the cone storage period.

Slash pine cone collections normally begin in early September. Although yields are usually adequate by late August for cones with a specific gravity of 0.95, reduced viability occurs. To obtain maximum germination, cones must be fully mature when collected and stored.

Biochemical analyses.—Like loblolly and longleaf, reducing-sugar content in slash pine seeds from unstored cones appeared closely related to maturation. Levels dropped rapidly for the last three collection dates (table 3).

Total sugars followed similar trends; the highest level (2.8 percent) occurred for cones collected earliest. Total sugars of seeds from unstored cones dropped to 0.6 percent at maturity. Cone storage markedly lowered total sugar levels of immature seeds but not of mature ones.

Lipids constituted only about 2.6 percent of seed weight in early collected seeds but increased to about 20 percent with maturation.

Table 3. *Characteristics of slash pine cones and seeds after various collection dates and storage periods*

Collection date (1971) and storage period (weeks)	Cone specific gravity	Cone moisture content	Seed yield per cone	Germination	Reducing sugars	Total sugars	Lipids	Insoluble nitrogen
		Percent	*Number*		*Percent*			
July 12	1.05	206.6	...	...	0.79	2.8	2.6	1.3
1			0	0	.19	.5	2.4	1.4
3			12	0	.04	.2	.9	1.0
5			13	0	.02	.1	.6	.8
Average			8	0	.26	.9	1.6	1.1
July 26	1.01	186.3	...	...	.75	2.8	7.7	2.0
1			0	0	.22	1.0	7.1	2.0
3			1	0	.04	.5	6.5	1.9
5			53	0	.03	.5	6.3	2.3
Average			18	0	.26	1.2	6.9	2.0
August 9	1.04	175.9	...	...	.77	2.7	13.8	2.9
1			0	6	.20	1.5	13.9	2.8
3			35	11	.01	.7	13.2	2.4
5			51	24	.00	.9	12.5	2.8
Average			29	14	.24	1.4	13.3	2.7
August 23	.99	160.7	...	...	.56	2.3	18.4	3.4
1			1	14	.25	1.4	19.7	3.7
3			36	58	.01	1.1	19.1	3.7
5			70	68	.08	1.1	20.3	4.3
Average			36	47	.22	1.5	19.4	3.8
September 7	.92	138.5	...	...	.49	1.5	20.6	4.1
1			6	49	.08	1.1	19.0	3.9
3			64	71	.00	1.3	21.7	4.4
5			70	67	.00	1.4	21.5	4.7
Average			47	62	.13	1.3	20.7	4.3
September 22	.81	126.8	...	...	.16	.6	19.6	4.3
1			70	54	.00	1.1	21.2	4.6
3			75	73	.03	1.3	21.5	4.4
5			85	83	.10	1.1	21.6	4.6
Average			77	70	.07	1.0	21.0	4.5

Cone storage did not affect lipid content. A 20 percent lipid content was necessary to ensure viability of 60 percent or greater. Sugars were apparently converted into lipids at maturation.

Protein-nitrogen contents also significantly increased with successive collection dates (table 3). For early collections, levels decreased with longer cone storage periods but thereafter increased only slightly or not at all. At maturity protein-nitrogen levels were slightly above 4 percent.

X-rays.—X-rays of slash pine seeds showed that the embryo is well-developed and the coat cavity filled when the seeds are mature and viable. There were large differences in the amount of the seed cavity filled by the embryo and megagametophyte between early and late collections (fig. 1). Seeds from the July collections showed little differentiation into embryonic and megagametophytic tissue; at this early stage, seed content appeared milky, indicating high sugar and protein-nitrogen contents. These observations were consistent with the germination data and the biochemical analyses.

CONCLUSIONS

Collections of slash and loblolly cones can begin 2 or 3 weeks before maturity if specific gravity is 1.0 or less, but yields will probably decrease even after cone storage. Acceptable yields and germination can be obtained when collections of loblolly cones begin about mid-September (specific gravity 1.0) and when collections of slash cones begin in late August (specific gravity 0.95). However, optimum yields and germination are possible only if the cones are mature when collected. Early collections are advisable only if large quantities of seed are needed immediately or if labor or the collectable crop is limited. Seeds from immature loblolly cones are apparently mature when extractable, and slash pine seeds continue ripening during cone storage. However, viability of longleaf seeds from immature cones decreases during storage. Therefore, only mature longleaf cones should be collected. Once ripe, longleaf cones can be stored from 3 to 5 weeks to increase seed yields without reducing viability, but the storage period should not exceed 8 weeks.

Moisture contents varied slightly among species but were usually near 120 to 140 percent at maturity.

For the species evaluated, reducing sugars offered the best potential biochemical index to maturity. For all three species, levels decreased to about 0.20 percent at maturity—when specific gravities were 0.88.

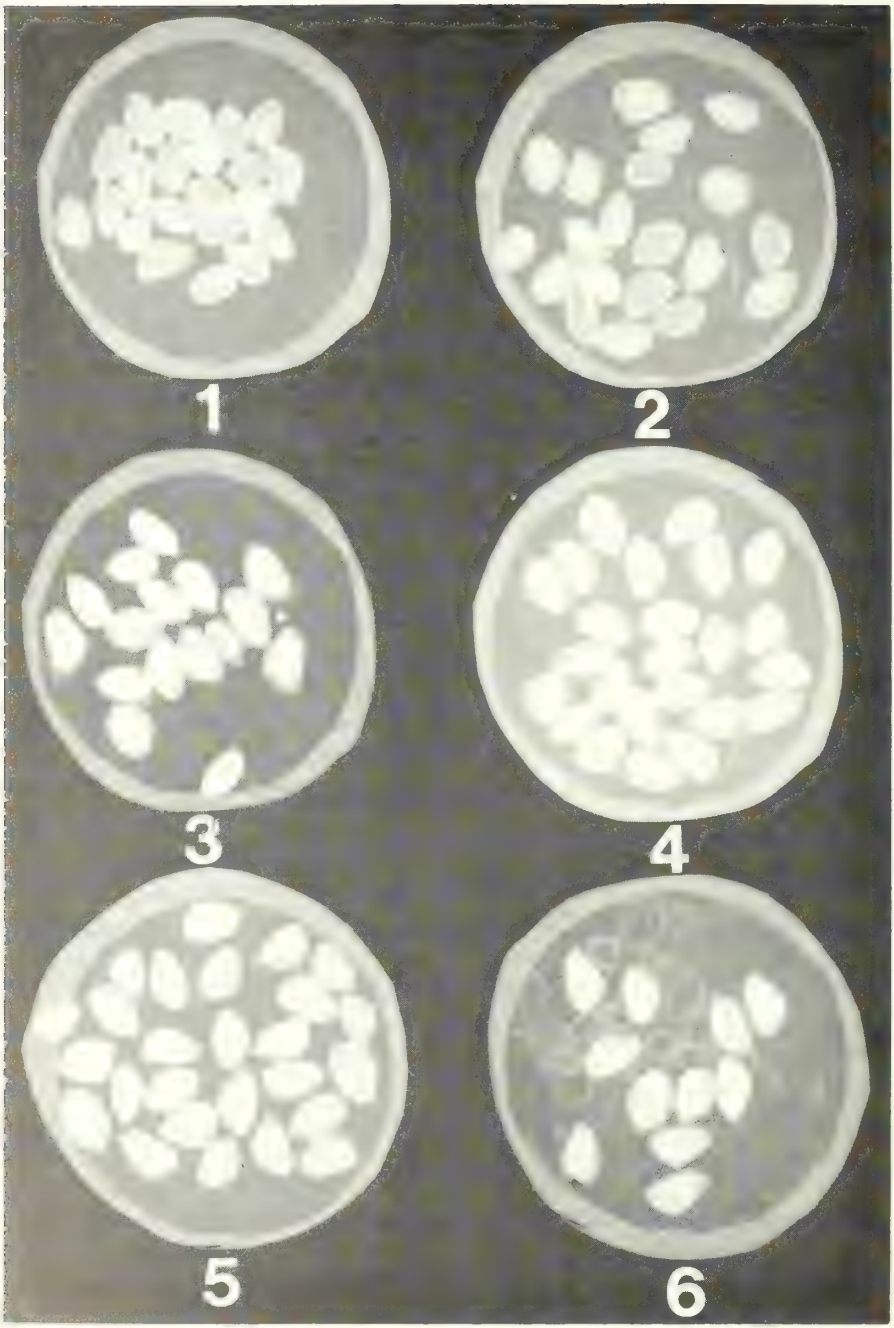

Figure 1.—*X-rays of slash pine seeds from one tree; cones were collected in 1971 on six dates as follows: (1) July 12, (2) July 26, (3) August 9, (4) August 23, (5) September 7, (6) September 22.*

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1976. Cone and seed maturation of southern pines. South. For. Exp. Stn., New Orleans, La. 11 p. (USDA For Serv. Res. Pap. SO-122)

If slightly reduced yields and viability are acceptable, loblolly and slash cone collections can begin 2 to 3 weeks before maturity if the cones are stored before processing. Longleaf (*P. palustris* Mill.) pine cones should be collected only when mature, as storage decreased germination of seeds from immature cones. Biochemical analyses to determine reducing sugar contents of seeds and x-rays to determine if the seedscoats are filled show promise as seed maturity indices.

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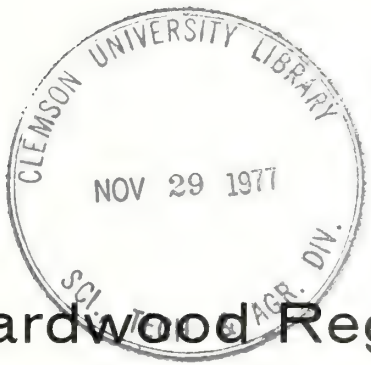

Hardwood Regeneration After Seed Tree Cutting

R. L. Johnson and R. M. Krinard

Southern Forest Experiment Station
Forest Service
U.S. Department of Agriculture

1976

Johnson, R.L., and R.M. Krinard

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R. L. Johnson and R. M. Krinard[1]

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Seed tree cutting is a system of regeneration that theoretically favors the establishment and subsequent growth of chosen species—particularly those whose seeds are disseminated by wind. Since the system is used infrequently in hardwood forests of the Midsouth, little documentation is available to support or disprove the assumption. This paper reports establishment and growth of trees in two separate stands 18 years after seed tree cutting. Seed trees were mainly sweetgums and red oaks.

METHODS

Both stands are in southeastern Arkansas on sites laced with a series of small drainage or depressional channels. One is within the floodplain of the Saline River and has good drainage nearly year-round. The other borders Chemin-a-haut Creek, a minor bottom cutting through upland pine forests; this area has poor drainage, particularly in winter and spring.

[1] The authors are stationed at the Southern Hardwoods Laboratory, which is maintained at Stoneville, Mississippi, by the Southern Forest Experiment Station, Forest Service—USDA, in cooperation with the Mississippi Agricultural and Forestry Experiment Station and the Southern Hardwood Forest Research Group.

Soil is Chastain silt loam on the Saline and Wrightsville silt loam on the Chemin-a-haut. Site indexes of sweetgum (*Liquidambar styraciflua* L.) and water oak (*Quercus nigra* L.) are 94 and 89 feet on Chastain soil and 89 and 80 feet on Wrightsville.

Before cutting, most trees in the Saline forest were suitable for large sawtimber; there were about 11,000 board feet (Int. ¼-inch rule) and 85 square feet of basal area per acre. Nearly half of the trees were red oaks, mainly cherrybark (*Quercus falcata* var. *pagodaefolia* Ell.) and water oak; about one-fourth were sweetgum. The Chemin-a-haut forest contained about 4,000 board feet and 61 square feet of basal area per acre. Approximately two-thirds were sweetgum; red oaks accounted for only 10 to 15 percent.

Three 7 by 14 chain blocks were delineated in each area. Sawtimber and pulpwood were cut in fall 1956. All unmerchantable trees 1.0 inch d.b.h. and larger were killed either by cutting or by girdling and poisoning. This left an average of 7.4 well-spaced seed trees per acre on the Saline and 7.5 trees on the Chemin-a-haut. Composition of the stands after cutting was as follows:

	Saline	Chemin-a-haut
	Trees per acre	
Sweetgum	2.3	5.2
Red oaks	4.0	1.2
White oaks	.5	.5
Blackgum (*Nyssa sylvatica* var. *sylvatica*)	.0	.3
Baldcypress (*Taxodium distichum* (L.) Rich.)	.3	.3
Green ash (*Fraxinus pennsylvanica* Marsh.)	.3	.0

Seed trees were removed from the Saline in 1962 but were not cut on the Chemin-a-haut.

During the summer and fall of 1957—about 1 year after cutting—both areas were fenced to exclude livestock. Twenty permanent plots were then established in each block; 10 were 0.004-acre plots 13.2 feet square, and 10 were circular 0.033-acre plots. Both sets of plots were equally spaced through the center of each block. Trees smaller than 1.0 inch d.b.h. were measured on the 0.004-acre plots, trees larger than 1.0 inch d.b.h. were measured on 0.033-acre plots.

Reproduction was monitored as follows: all trees on the square plots were tallied by species in the falls of 1957, 1958 (Saline only) and 1959. Beginning in fall 1962 and again in the falls of 1965, 1971 (Saline only), and 1974, all trees were tallied by species on the circular

plots. In 1971 heights and diameters of the tallest tree of each species were recorded for all plots. In 1974 diameters of all trees and the height of a dominant or co-dominant tree for each species were recorded, and volume of reproduction was calculated for all plots except those containing seed trees or surviving girdled trees.

RESULTS

Saline

One, two, and three years after cutting there were 3,800, 7,300, and 13,000 total trees per acre, respectively; after 6 and 9 years, 700 and 1,600 trees per acre 1.0 inch d.b.h. and larger were tallied.

At the end of the 18 years, the stand had 1,800 trees per acre comprised of 34 species (table 1). Nearly three-fourths were American hornbeam (*Carpinus caroliniana* Walt.), sweetgum, or river birch (*Betula nigra* L.). These three species became plentiful during the second year after cutting. After 9 and 18 years, the number of sweetgum remained steady or increased slightly; American hornbeam increased substantially, and river birch decreased. Red oaks never comprised a large proportion of the reproduction even though they doubled or tripled in number between 9 and 18 years after cutting. After 18 years, they accounted for only 9 percent of the trees, and none was as large as 7.0 inches d.b.h. (table 2).

Proportionate numbers of trees by species varied considerably among blocks. For example, after 18 years one block had twice as many sweetgum as the other two; the second had two to three times as many red oaks, and the third block had two to four times as many American hornbeam.

By 1974, there were 150 to 200 dominant or co-dominant trees per acre (based on tree size and location) in fully stocked stands.

Table 1.—*Reproduction by species groups and measurement year*[1] *on the Saline*

Species	Measurement year					
	1957 1	1958 2	1959 3	1962 6	1965 9	1974 18
	Number of trees per acre					
Sweetgum	956	705	2,074	189	396	489
River birch	0	...[2]	3,566	226	548	308
Red oaks	969	398	710	7	63	153
American hornbeam	624	...[2]	887	112	271	513
Others	1,264	6,213	6,092	194	286	351
Total	3,813	7,316	13,330	728	1,564	1,814

[1] 1957, 1958, and 1959 data were from milacre plots; in 1962 and afterward, data were from 0.033-acre plots.

[2] Included under *Others*.

Table 2.—*Number of trees per acre after 18 years by species groups and d.b.h class (Saline)*

D.b.h. class	Sweetgum	Red oaks	River birch	Other major species	American hornbeam	Other minor species	Total
	Number of trees per acre						
1.0–1.9	144	65	52	78	310	110	759
2	114	31	107	39	127	38	456
3	69	29	97	22	40	9	266
4	50	17	27	16	12	1	123
5	46	10	23	14	3	1	97
6	42	2	6	6	2	...	58
7	18		5	8	3	...	34
8	10		1	5	1	2	19
9	1			2			3
10	1						1
Total	495	154	318	190	498	161	1,816

Sweetgum was dominant or co-dominant on 86 percent of the plots, red oaks on 52 percent, and river birch on 45 percent. Only 9 percent of the dominant or co-dominant trees measured were established as new seedlings, 24 percent were advance reproduction (well-established when the stand was cut), and 68 percent were sprouts from stumps or roots of cut trees.

Most reproduction did not grow into the 2-inch diameter class until 1962, 6 years after cutting. In plots with poor stocking, trees did not emerge from the vines and briars until 1965. Dominant trees were 15 to 20 feet tall in 1962, 25 to 35 feet tall in 1965, 40 to 50 feet tall in 1971, and 55 to 65 feet tall in 1974. Average d.b.h. of all trees $\geq$1.0 inch was 3.2 inches in 1974, while dominants were 6 to 10 inches d.b.h.

Estimated plot volumes in 1974 for all trees 1.0 inch d.b.h. or greater ranged from 1,325 to 2,624 cubic feet per acre. Basal areas ranged from 73 to 142 square feet per acre. When considering only trees $\geq$5.0 inches d.b.h., plot volumes ranged from 118 to 2,134 cubic feet per acre and basal areas from 5.7 to 104.2 square feet per acre. Growth averaged 98 cubic feet annually for trees 1.0 inch d.b.h. or larger and 56 cubic feet for trees 5.0 inches or larger. Highest volume production was from plots with dense clumps of sweetgum, which contributed nearly 50 percent of the total volume compared to only 7 percent for red oaks.

Chemin-a-haut

One and 3 years after cutting, there were 5,700 and 2,700 total trees per acre, respectively; after 6 and 9 years, 600 and 900 trees per acre 1.0 inch d.b.h. and larger were tallied.

At the end of 18 years, the stand had 1,300 trees per acre made up of 23 species. Nearly 80 percent of the trees were about equally divided between sweetgum and American hornbeam (table 3). Both species were well represented the first year after cutting. Between years 9 and 18, sweetgum stocking remained generally stable, but the number of American hornbeam nearly doubled. Red oaks were never a major component of the stand, although the number tallied increased by about one-third between 9 and 18 years. By 1974, red oaks made up only about 5 percent of the trees; few were larger than 6 inches d.b.h. (table 4). No other species comprised more than 3 percent of the 18-year-old stands.

Table 3.—*Reproduction by species groups and measurement year*[1] *on the Chemin-a-haut*

Species	Measurement year				
	1957	1959	1962	1965	1974
	1	3	6	9	18
	Number of trees per acre				
Sweetgum	567	558	363	517	584
Red oaks	142	83	31	51	63
American hornbeam	...[2]	...[2]	103	254	492
Others	4,950	2,042	82	118	195
Total	5,659	2,683	579	940	1,334

[1] 1957 and 1959 data were from milacre plots; in 1962 and afterward data were from 0.033-acre plots.

[2] Included under *Others*.

As on the Saline, there were about 150 to 200 dominant or co-dominant trees per acre in dense stands. Sweetgum was dominant or co-dominant on 97 percent of the plots and red oaks on 31 percent. About 63 percent of the dominants or co-dominants were of sprout origin; advance reproduction accounted for 28 percent and new seedlings for only 9 percent.

In 1974, average d.b.h. of trees $\geq$1.0 inch was 3.4 inches, whereas dominant trees were 50 to 65 feet tall and 6 to 10 inches d.b.h. Plot volumes based on trees 1.0 inch d.b.h. or larger ranged from 280 to 3,253 cubic feet per acre. Basal areas ranged from 20 to 157 square feet per acre. Volumes for trees 5.0 inches d.b.h. and larger ranged from 0 to 2,805 cubic feet (0 to 127 square feet of basal area). Growth averaged 86 cubic feet annually for trees 1.0 inch d.b.h. and larger and 53 cubic feet for trees 5.0 inches and larger.

Nearly 75 percent of the Chemin-a-haut volume was in sweetgum and only 9 percent in red oak.

Table 4.—*Number of trees per acre after 18 years by species groups and d.b.h. class (Chemin-a-haut)*

D.b.h. class	Sweetgum	Red oaks	Other major species	American hornbeam	Other minor species	Total
	Number of trees per acre					
1.0–1.9	106	18	70	300	38	532
2	113	9	25	140	17	304
3	108	18	13	45	13	197
4	91	3	7	7	7	115
5	80	3	5	1	1	90
6	58	5	...	...		63
7	22	...	3	1		26
8	7	2	1			10
9	5	1	1			7
10		1				1
11		1				1
Total	590	61	125	494	76	1,346

DISCUSSION

In the present study seed trees did not appear to affect establishment or development of reproduction. A clearcut would probably have given the same results, since most reproduction came from the stumps and roots of cut trees or from seedlings already in the understory at time of cutting (table 5). After 18 years, sweetgum of root and stump sprout origin was by far the leading commercial species both in number and stand position (dominance) on both areas (fig. 1). All red oaks present were already well-established in the understory at the time of cutting. The American hornbeams were a combination of new seedlings, advanced reproduction, and stump and root sprouts. The only new seedlings of significance were river birch and American sycamore on the Saline, although most of the sycamore were dead after 9 years.

After cutting, stands with a high percentage of sweetgums in the overstory will apparently reproduce heavily to sweetgum because of sprouting. In this test, sweetgum sprouts emerged for at least 3 years after cutting, and their early rapid growth—up to 6 feet the first year—enabled them to become dominant. We saw no reason to disfavor root or low stump sprouts in managing the stand, since they developed and competed well, showed no tendency to rot, and would therefore become suitable as sawtimber crop trees. Although sprouts from high stumps grew well, some contained rot and were unsuitable as sawtimber. It is therefore best to keep sweetgum stumps as low as possible.

Of the common commercial species, red oaks (cherrybark and water oak) appeared the most competitive. When these oaks received

Table 5.—*Predominant sources of reproduction 18 years after seed tree cutting on two sites*

Species	New seedlings	Advanced seedlings	Root and stump sprouts
American hornbeam	X	X	X
Ash, green		X	X
Baldcypress	X		
Birch, river	X		
Buttonbush (*Cephalanthus occidentalis* L.)	X		X
Eastern cottonwood (*Populus deltoides* Bartr.)	X		
Elm spp. (*Ulmus* L.)		X	
Gum, sweet			X
Gum, black		X	
Holly, American (*Ilex opaca* Ait.)	X	X	X
Hawthorn spp. (*Crataegus* L.)		X	
Hickory spp. (*Carya* Nutt.)		X	X
Honeylocust (*Gleditsia triacanthos* L.)			X
Maple, red (*Acer rubrum* L.)	X		X
Mulberry, red (*Morus rubra* L.)		X	X
Oak, cherrybark		X	
Oak, swamp chestnut (*Quercus michauxii* Nutt.)		X	
Oak, water		X	
Oak, willow (*Quercus phellos* L.)		X	
Pawpaw (*Asimina triloba* (L.) Dunal)		X	
Persimmon (*Diospyros virginiana* L.)		X	
Sassafras (*Sassafras albidum* (Nutt.) Nees)	X	X	
Sugarberry (*Celtis laevigata* Willd.)		X	
Sycamore, American (*Platanus occidentalis* L.)	X		
Water hickory (*Carya aquatica* (*Michx.* f.) Nutt.)		X	X
Willow, black (*Salix nigra* Marsh)	X		

direct overhead sunlight and when their growing tips were halfway up the live crowns of competitors, they appeared vigorous and eventually capable of dominating. A relatively high number of red oaks were dominant and co-dominant despite their comprising a small proportion of the total stocking. Stands made up predominantly of red oak before cutting may not reproduce to red oak. The best way to assure the presence of these trees in the mature stand is to leave many established seedlings in the understory. Advanced oak reproduction at least 5 to 10 feet tall at the time of cutting will apparently compete much better than oaks less than 2 feet tall.

River birch seedlings—the only important new growth—grew only on the Saline, which had a seedbed of bare mineral soil conducive

Figure 1.—*Eighteen-year-old sweetgum sprouts from a stump 6 inches in diameter. Machete is pointed at the top of the stump.*

to the establishment of light-seeded species. Also, overflow of the Saline River during the spring provided a favorable distribution of river birch seed and a moist seedbed during the germination period. River birch was a rapid early grower but a poor competitor. In competition with the other species, young river birch bent toward sunlight, resulting in a crooked tree that frequently succumbed as competition became intense.

American hornbeam sprouted prolifically and developed slowly in almost complete shade. Sprouts grew to 4 or 5 feet the first year. In spite of their rapid early growth, American hornbeam competing from ground level poses no threat to most commercial species. However, dense clumps of American hornbeam containing individual trees 3 to 6 inches d.b.h. and 20 to 30 feet tall will dominate and eventually kill reproduction of better species that attempt to develop underneath.

Results from this test suggest that seed trees will not lead to widespread establishment of red oak and sweetgum seedlings. Seed trees of most hardwood species are unlikely to play a significant role in establishing new stands because of competition from the advanced reproduction and sprouts common to hardwood forests in the Midsouth. Establishing a new stand from seeds after seed tree cutting apparently requires adequate seeds, a seedbed relatively free of grass or herbaceous plants, and adequate surface soil moisture during the germination period. When this unlikely combination occurs, the resulting seedlings must grow rapidly enough to move into an early dominant position.

FOREST SERVICE
RESEARCH PAPER SO-124

POPULUS 1964

A BIBLIOGRAPHY OF WORLD LITERATURE

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USDA Forest Service Research Paper 124

Populus:
A Bibliography of World Literature
1964 - 1974

Compiled by **Earl D. Hart**
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University of New Orleans

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U.S. Department of Agriculture

1976

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Populus:

A Bibliography of World Literature

1964 - 1974

The World of Populus ...

The study of populus — the most ubiquitous tree species in the world — has drawn the increasing attention of professional foresters during the past 11 years. This is evidenced by the number of citations published in this volume, which amounts to at least twice the number published in the first bibliography.[1] That one, citing studies from 1854 through 1963, covered 110 years of scientific research!

Like its forerunner, this bibliography is intended as a comprehensive reference for international use by researchers and land managers. Most of the references and abstracts (abbreviated by Station scientists) were provided by the Commonwealth Forestry Bureaux. However, many other citations published here were furnished by the National Agricultural Library's CAIN reference service and by the various nations interested in populus study. Every effort has been made to avoid duplications but, if some are yet lurking on the premises, we plead for the reader's forbearance. It is highly possible, for example, that duplications exist in the section titled Miscellaneous. These are citations, submitted without English title translations, which could not be classified.

For consistency, this bibliography is arranged in the same order as the first volume: by species or groups of species, then by subject-matter categories. References dealing with poplars in general or with several species are grouped under the head *Populus* spp.

Three features are included to ease the labors of researchers. One is the Author Index, which appears in the back. Another is the Key to Subject-Matter Classification, presented in advance of the citations. Numerals in the Key refer to subject-matter assignments based upon the **Oxford System of Decimal Classification for Forestry**, the authorized English version of which was published by the Commonwealth Agricultural Bureaux. And finally, a Supplementary Guide is included to aid those who do not have a copy of the Oxford Classification.

To most efficiently use the bibliography, the reader should refer first to the Table of Contents for species and then to the Key for subject matter. Information on titles of publications cited and other aspects of the citation entries will be found in **Guide to the Use of Forestry Abstracts**, also available from the Commonwealth Agricultural Bureaux.

One more point: Time lags exist between publication of reports and the availability of their abstracts. While all citations available from 1974 at publication time are included, the reader should be aware that others could be added to **Forestry Abstracts** at a later date.

[1] Farmer, R. E., Jr., and McKnight, J. S. 1967. *Populus* : a bibliography of world literature, 1854-1963. Southern Forest Exp. Sta., New Orleans, La. (U.S. Forest Serv. Research Paper SO-27) 132 pp.

Key to Subject-Matter Classification

0 GENERAL

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- 11 Site Factors: Climate, Situation, Soil Hydrology
  - 111 The Atmosphere. Meteorology. Climate and Microclimate.
  - 114 Soil. Soil Science
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- 14 Systematic Zoology
  - 145 Articulata
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Deals with role of timber merchants on Dutch poplar wood market.

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1 FACTORS OF THE ENVIRONMENT. BIOLOGY

11 SITE FACTORS: CLIMATE, SITUATION, SOIL, HYDROLOGY

111 THE ATMOSPHERE. METEOROLOGY. CLIMATE AND MICROCLIMATE

Bahno, E. S. 1967. [THE DISTRIBUTION OF POLLEN OF WOODY PLANTS IN THE AIR OF KIEV.] Vracebnoe Delo, Kiev 4), (106-8). [[Ru.e.] N.L.L.]
Analyses results of a pollen survey made in 1963, suggesting that allergies may be caused by the pollen of Willow, Oak, Pine and Poplar in the spring.

114 SOIL. SOIL SCIENCE

Anonymous. 1964. [FERTILIZING AND SITE IMPROVEMENT IN FORESTRY.] Tagungsberichte, Deutsche Akademie der Landwirtschaftswissenschaften zu Berlin No. 66, pp. 247 + 5 tbls. Many refs. [G.g.ru.e.] C.G.B.]
Papers, mainly by E. German scientists, on various aspects of tree nutrition, including foliar and soil analyses, presented at a dies academicus at Tharandt in 1963.

Caporali, G. 1969. [SERIOUS LASTING LIMITATIONS IN THE CULTURE OF POPLAR IN DRY AREAS AND IN TERRITORIES WITH PERTINENT HYDROLOGICAL PROBLEMS.] Agr. Venezie 23 (3): 290-293. [It.]

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114.2

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Tabulates data for Populus X 'canadensis', Fraxinus excelsior, Acer platanoides and Robinia pseudoacacia, all aged 25 or 27.

Licmanov, B. V., and Dolgov, S. I. 1964. [THE EFFECT OF SHELTERBELTS IN THE KULUNDA STEPPE [ALTAI REGION] ON THE DISTRIBUTION OF HUMUS AND CARBONATES IN THE SOIL.] Pocvoved. (9), (11-8). 14 refs. [Ru.ru.e.] A.P.B.
Comparisons were made of chestnut soils under (a) wheat, (b) a 28-year Poplar shelterbelt, and (c) a 30-year Birch shelterbelt. In the top 0-75 cm. of the soil, humus contents were respectively 16·1 – 16·2, 18·8, and 25·2 kg./sq. m. for (a), (b) and (c). During the life of the shelterbelts, 50·4 kg. of carbonates per sq. m. had been leached from the top 105 cm. of soil in (b), and 67·4 kg. from the top 140 cm. in (c).

114.3

Dormaar, J. F. 1967. INFRARED SPECTRA OF HUMIC ACIDS FROM SOILS FORMED UNDER GRASS OR TREES. Geoderma, Amsterdam 1 (1), (37-45), [18 refs. [E.e.] N.L.L.]
The infra-red absorption spectra of various humic acids from a number of Canadian soils have been examined to establish whether the 2500–1800 cm.$^{-1}$ spectral region may be used to distinguish between soils formed under grass or under trees or to separate chernozemic from podzolic organic matter. Results appear to support the hypothesis that the spectral slope or configuration in this region is related to the molecular weight of the material examined and to the vegetation under which the humic substances are formed or transformed.

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A soil sequence was found under a succession from rough fescue prairie to encroaching Poplars and Douglas Fir in the Porcupine Hills. During the 80 years of encroachment, eluviation increased and % of exchangeable Ca decreased, but Ca remained the dominant cation. Organic matter had changed much more than mineral matter.

Giulimondi, G. 1966. LA DECOMPOSITION DE LA LITIERE DE PEUPLIER DANS LE SOL. Proc. 6th World For. Congr. 2:2537-41. [F.]

114.4

Waenink, A. W. 1974. [A RESEARCH ON THE SOIL PROPERTIES OF AN ARTIFICIAL LAND AND THE GROWTH OF POPLAR ON THE DIFFERENT SOIL TYPES.] Stichting voor Bodemkartering, Wageningen, the Netherlands, report 1201. [Du.]

114.52

Palotas, F., Simon, M., and Szodfridt, I. 1969. EXPERIENCES IN SOIL INVESTIGATION OF PULP-POPLAR STANDS OF DUNA-TISZAKOZ. Erdo 18 (1): 27-30. [Hu.]

114.521

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Reviews use of radioactive isotopes in research on wood and paper, plant physiology and nutrition, pest control and fungus diseases, and in genetics and dendrochronology.

114.54

Meiden, H. A. van der. 1964. [MANURING POPLARS WITH POTASSIUM.] La Foret Privee, nov./dec., nr. 40 (123-127) and jan./fev. 1965, nr. 41 (109-112). [F.]

114.6

Anonymous. 1964. [LITTER CONSUMPTION BY MACRO-FAUNA.] Meded. Inst. Toegep. Biol. Onderz. Nat. No. 65, (25-8, 53). [Du.e.]
Studies of millipedes, woodlice and snails showed that high litter consumption is usually accompanied by low retention (Hazel, Alder, Birch), but that with less favoured foods (Oak and Poplar) both consumption and retention were low.

Graff, O., and Satchell, J. E. [Editors]. 1967. HUMAN INFLUENCES ON THE SOIL COMMUNITY. In Progress in Soil Biology (Proceedings of the Colloquium on Dynamics of Soil Communities, Braunschweig-Volkenrode 1966). North Holland Publishing Company, Amsterdam. pp. 265-394. [E.G. or F.e.]
Includes development of the macro- and mega-fauna on reclaimed spoil mounds (W. Dunger [G.]) [a study near Gorlitz on mounds planted with Alnus glutinosa, Robinia pseudoacacia and Populus spp.].

Leval, J. DE, and REMACLE, J. 1969. A MICROBIOLOGICAL STUDY OF THE RHIZOSPHERE OF POPLAR. Plant & Soil. 31 (1), (31-47). [71 refs. [E.e.f.].]
Differences in the rhizosphere microflora were studied in Populus 'Robusta' plantations ranging in age from 2 to 19 years. The total number of bacteria and actinomycetes averaged 16 X 10^6 propagules/g. dry soil, and length of mycelia 7 m./g. In the older plantations the total microflora was very similar, whereas in the younger ones (2 and 6 years old) the microflora differed from that of the older ones in composition and was less active.

Marcuzzi, G. 1971. FIRST RESULTS OF THE STUDY OF THE SOIL FAUNA OF TWO ITALIAN ARTIFICIAL ECOSYSTEMS. Pedobiologia 11 (4), (304-5). [E.de., 3 ref. OZ]

Marcuzzi, G. 1973. [THE SOIL FAUNA OF A POPLAR STAND AT CESURNI (BAGNI DE TIVOLI).] Pubblicazioni del Centro di Sperimentazione Agricola e Forestale 12, 137-152 + 1 pl. [It.e., 18 ref.]

Study of soil fauna in a Poplar stand on a farm near Rome in relation to the site and climate and to seasonal changes and stand treatments, and compares the data with observations recorded in (a) a semi-natural environment close to the stand and (b) a Poplar plantation in Belgium. There was considerably more variety in the soil fauna in (a) than in the stand studied, and there were marked differences in the fauna between the stand and (b).

Rambelli, A. 1966. [INVESTIGATIONS ON THE RHIZOSPHERE OF POPLARS.] Pubbl. Cent. Sper. Agric. For., Roma 8, (27-37). [6 refs. [It.it.e.e.].]
The total microflora of the rhizosphere was investigated. The rhizosphere effect was apparent both from the concentration of the microflora, in which the population was more numerous near the roots (a) than on the root surface (b) or in the surrounding soil (c), and also (more clearly) from the behaviour of the microbial groups, bacteria isolated from (a) being predominantly those stimulated by amino acids and from (b) those influenced by vitamins. Ignoring the distinction between (a) and (b), a comparison of the rhizosphere effect in (1) Poplar, (2) Pine [cf. F.A. 26 No. 3207] and (3) Eucalypts [cf. F.A. 25 No. 1614] indicates that amino acids have an effect in (1), (2) and (3), but vitamins in (1) and (3) only.

114.67/.68

Marcuzzi, G., and Venezia, L. D. 1972. FIRST RESULTS OF THE STUDY OF THE SOIL FAUNA OF TWO ITALIAN ARTIFICIAL ECOSYSTEMS. Revue d'Ecologie et de Biologie du Sol. 9 (2), (229-233). [E., 7 ref.]

116 HYDROLOGY. WATER CONSERVATION, SOIL CONSERVATION AND EROSION

Baker, M. B., Jr. 1972. SPRING RUNOFF AS AFFECTED BY SOIL PERMEABILITY ON TWO FORESTED WATERSHEDS. Dissertation Abstracts International. B 32 (11) 6503 [E., ORS, Order No. 72-14,269]
Reports investigation in two 1-acre catchments in Minnesota. One catchment had a clay soil with Pine overstorey, and the other had a sandy soil with Aspen/Birch cover; both were studied for three winters.

Brenner, R. P. 1973. A HYDROLOGICAL MODEL STUDY OF A FORESTED AND A CUTOVER SLOPE. Hydrological Sciences Bulletin. 18 (2) 125-144 [E., 12 ref.] From Geo Abstracts 74B/1641. ORS.
The problem of analysing and predicting the effect of vegetation removal on the hydrologic regime or soil water potential on steep slopes was examined by means of an experimental model set up in a greenhouse.

Kraayenoord, C. W. S. van. 1968. POPLARS AND WILLOWS IN NEW ZEALAND WITH PARTICULAR REFERENCE TO THEIR USE IN EROSION CONTROL. CIP/13/32. 13th Session Int. Poplar Commission, Montreal; 18 pp.

Traci, C. 1970. [THE TECHNICAL AND ECONOMIC EFFICIENCY OF SOME FOREST PLANTATIONS ON DEGRADED SITES.] Rev. Padurilor 85 (12), (710-6). [Rum. 2 refs.]
Tabulates current costs of establishing P. nigra on eroded sites in Rumania, and of 'canadensis', on gully bottoms; the performance of 15- to 80-year-old plantations of these species on a range of sites in different climatic zones; and the expected value and yield of timber on non-eroded sites. P. sylvestris performs better than P. nigra on all sites except rocky karsts and eroded clays.

Traci, C. 1973. [SOME DATA ON THE HYDROLOGICAL, ANTI-EROSION AND AMELIORATIVE ROLE OF FOREST PLANTATIONS ON ERODED SITES.] Revista Padurilor 88 (12) 668-672 + smries. [Ro.fr.ru.de.e., 6 ref.]
Discusses measurements of soil erosion in small experimental catchments, and observations on soil development and litter and humus accumulation, in five afforested areas in different parts of the Rumanian Carpathians. Notes are given on effectiveness of hybrid Black Poplars for stabilizing the bottoms of ravines.

Zivanov, N. 1974. [THE AMOUNT OF PRECIPITATION INTERCEPTED BY THE CROWNS OF POPULUS 'I-214'.] Topola 18 (100/101) 105-111 [Sh.e., 7 ref.]
Describes results of rainfall measurements from 1968 to 1973 in a plantation in Yugoslavia. Amount of precipitation intercepted by the crowns increased with increasing amount of rainfall.

14 SYSTEMATIC ZOOLOGY

145 ARTICULATA

145.7

Richards, W. R. 1972. THE CHAITOPHORINAE OF CANADA (HOMOPTERA: APHIDIDAE). Memoirs of The Entomological Society of Canada No. 87, vi + 109 pp. [E., 52 ref. ORS]

Asahina, E., and Tanno, K. 1964. A LARGE AMOUNT OF TREHALOSE IN A FROST-RESISTANT INSECT. Nature, Lond. 204 (4964), (1222). 8 refs.
The overwintering pre-pupal larvae of a Poplar sawfly, Trichiocampus populi, were found to survive freezing, and an extraordinarily large amount of a sugar, trehalose, was detected in the insect. The concentration of sugar was comparable to that in very frost-hardy plants.

15 ANIMAL ECOLOGY

Balazs, I. 1971. [RELATIONS BETWEEN AGRICULTURAL POPLAR PLANTATIONS FOR PULPWOOD PRODUCTION AND ROEDEER POPULATIONS.] Erdo 20 (9), (393-5). [Hu.]
Discusses causes (and implications) of the increases in roedeer populations associated with the large-scale establishment of Poplar plantations for pulpwood production.

Behrend, D. F., and Patric, E. F. 1969. INFLUENCE OF SITE DISTURBANCE AND REMOVAL OF SHADE ON REGENERATION OF DEER BROWSE. J. Wildlife Mgmt. 33 (2), (394-8). [5 refs. N.L.L.]
Burning resulted in the greatest variety of browse species, including Populus spp.

Siebert, H. 1973. [ESTABLISHMENT AND TENDING OF WOODY-BROWSE PLANTATIONS FOR DEER.] Merkblatt, Forschungsinstitut fur Pappelwirtschaft Hann. Munden No. 6, 12 pp. [De.]
Advises on sites and their preparation, suitable species of Willow and Poplar, planting of (bought or home-grown) cuttings or rooted cuttings, tending, fertilizing, fencing etc. Assuming a utilization period of 25 years, costs would be less than for the provision of herbaceous browse on cultivated deer pastures.

151 MODE OF LIFE, AUTECOLOGY, HABITS, ADAPTABILITY

151.41

Dusek, J. u., Kristek, J. 1967. ZUR KENNTNIS DER SCHWEBFLIEGENLARVEN (DIPTERA, SYRPHIDAE) IN DEN GALLEN DER PAPPELBLATTLAUSE (HOMOPTERA, PEMPHIGIDAE). Z. Angew. Entomol., Hamburg u. Berlin 60, 1, 124-136, 3 Abb., 3 Tab., Lit. Ang., engl. Zsfg.

153 FLUCTUATIONS AND CYCLES OF POPULATION

Jahn, Else, and Sinreich, Anna. 1965. BEOBACHTUNGEN ZUR MASSENVERMEHRUNG DES WEIDEN– ODER PAPPEL-SPINNERS, STILPNOTIA SALICIS L. IN WINDSCHUTZSTREIFEN IM SEEWINKEL DES BURGENLANDES IN DEN JAHREN 1962 UND 1963. Anz. Schadlingskde., Berlin u. Hamburg 38, 2, 17-23, 9 Abb., 3 Tab. Lit. Ang., engl., franz. u. russ. Zsfg.

16 GENERAL BOTANY

160 PLANT CHEMISTRY

Bartels, H. 1965. [THE PROTEIN AND ENZYME CONTENTS OF TREE LEAVES.] SchrReihe Forstl. Fak. Univ. Gottingen 33, 1963 (11-21). 10 refs. [G.]
Preliminary results of study on Black Poplar hybrids and Beech. In Poplar, protein contents and enzyme activity per sq. cm. of leaf varied with position on shoot and season. Glutamate aspartate (GOT) was high in June and Sept., and aldolase (ALD) in summer. In fertilizer trials, GOT increased with increasing nutrient content, while ALD and malatohydrogenase (MHD) remained constant or decreased. Reactions differed significantly between clones.

Coccia, L. 1967. [CHEMOTAXONOMIC DIFFERENTIATION OF POPLAR CLONES.] Proc. 14th Congr. Int. Union For. Res. Organ., Munich Pt. III, Sect. 22, (581-95). [12 refs. [F.f.].]
Alcohol extracts of leaves and bark were analyzed chromatographically. Best results were obtained with leaf extracts. Results are listed for a large number of clones of sections Leuce and Aigeiros, and schematic diagrams are presented. Although, on the basis of flavonoid contents, there are analogies between clones from the same cross, the method cannot be used for establishing relationships between hybrids and their parents.

Corlateanu, E. 1971. [STUDY OF SOME CELLULOSE FIBRES: POPLAR WOOL. I. HEMICELLULOSES.] Celuloza si Hirtie 20 (10) 435-7 [Ro., 17 ref.] From Cellulosa e Carta 24 (3), 40-1. [It.]
Describes a study of hemicelluloses extracted from Poplar wool [pappus ?], showing that they are hydrolysable in weak acids and are predominantly composed of xylose.

Delova, G. V. 1967. [PHYTOCIDAL CHARACTERISTICS OF CERTAIN SPECIES OF POPLAR.] In Mikroorganizmy i zelenoe rastenie. 'Nauka', Novosibirsk. 1967. pp. 98-114. [Ru.]

P.a. of comminuted bark of all the Poplars against Actinomyces fradii was very great in early spring. In most Poplars, p.a. of the bark decreased in late July, but in some species it increased again towards the end of the growing season. P.a. of the bark against bacteria in early spring was even greater. P.a. of comminuted buds against A. fradii varied with species and with the season in which the buds were taken. Spring buds had no p.a. against bacteria. Volatile and non-volatile phytocidal substances from young growing leaves had very high p.a. against A. fradii. P.a. of autumn leaves of most species against A. fradii was also high. When leaves were dried and remoistened, some species lost their p.a. against A. fradii but others did not. The p.a. against bacteria decreased greatly in periods of high temperature and drought.

Donov, V., Beleva, E., and Iorova, K. 1973 [URANIUM AS A TRACE ELEMENT IN FOREST PLANTS.] Gorsko Stopanstvo 29 (11) 8-12 [Bg.]
Tabulates preliminary data on the content of U^{238} in the various soil horizons on unidentified sites in Bulgaria.

Dzaparidze, L. I., and Mikeladze, E. G. 1969. [SEXUAL DIFFERENCES IN THE COMPOSITION OF FREE AMINO ACIDS IN THE LEAVES OF DICOTYLEDONOUS PLANTS.] Fiziol. Rast. 16 (1), (147-50). [9 refs. [Ru.] A.P.B.]
Tabulates data on the contents of free amino acids in the leaves of ♂ and ♀ plants of ten species, including Populus nigra, and Populus sp. In all, 17 free amino acids were found.

Garbaye, J. 1972. [INFLUENCE OF DATE AND HEIGHT OF SAMPLING ON THE RESULTS OF FOLIAR ANALYSIS OF TWO POPLAR CLONES.] Annales des Sciences Forestieres 29 (4) 451-463 [Fr.e.de., 15 ref.]
Leaves from the upper part of the tree are the most useful for foliar analyses because they contain the largest amounts of major nutrients and their more active metabolism gives a better idea of the nutritional state of the tree.

Golysheva, M. D. 1971. [A HISTOCHEMICAL INVESTIGATION OF LEAVES OF CERTAIN REPRESENTATIVES OF THE SALICACEAE.] Biol. Nauki (6), (65-72). [Ru., 40 ref. NLL]
Discusses the location and seasonal variation in the content of tanstuffs, peroxidase and reducing sugars in leaves of Populus (3 species), and the physiological significance of the findings.

Haissig, B. E., and Schipper, A. L. 1971. EFFECT OF IONIC STRENGTH ON RECOVERY OF PLANT ENZYMES IN EXTRACTS PREPARED WITH ANION EXCHANGE RESIN. Biochem. Biophys. Res. Commun. 45 (3): 598-605.

Kazaryan, V. O., Khurshudyan, P. A., and Gabrielyan, G. G. 1971. [DEPENDENCE OF THE PEROXIDASE AND POLYPHENOLOXIDASE ACTIVITY GRADIENT IN POPLAR ROOTS ON THE SOIL MOISTURE CONTENT.] Dokl. Akad. Nauk Armyan. SSR 53 (1): 53-57 [Ru.arm., 14 ref.]
The activity was determined at various distances from the root-collar in Canadian Poplars growing in soil (a) with adequate moisture, and (b) with diminishing moisture. In (a) the enzyme activity increased from the root-collar to the thin terminal roots, whereas in (b) the gradient of enzyme activity was in the opposite direction. The over-all enzyme activity was greater in (b) than in (a). This reversal of enzyme activity is also a feature of aging.

Khashes, Ts. M. 1972. [DIURNAL AND SEASONAL VARIATION OF THE POTASSIUM CONTENT IN LEAVES OF WOODY SPECIES UNDER IRRIGATION.] Lesovedenie No. 5, 53-61 [Ru.e., 27 ref.]
Gives data in graphs on the diurnal and seasonal changes in the K content of leaves of Populus X berolinensis growing on the margins of shelterbelts planted along irrigation canals. Diurnal variations showed a positive correlation with the diurnal rhythm of transpiration and showed peaks in the morning on E. and S. margins and in the afternoon on W. and N. margins. Seasonal variations were governed by the characteristics of the individual species.

Klimczak, M., Kahl, W., and Grodzinska-Zachwieja, Z. 1972. PHENOLIC ACIDS, DERIVATIVES OF CINNAMIC ACID, IN PLANTS. Dissertationes Pharmaceuticae et Pharmacologicae 24 (2), 181-185 [E.pl., 11 ref.]

The content of phenolic acids was determined in the bark, buds and leaves of several Poplar species and hybrids cultivated in Poland. All the samples contained chlorogenic acids. Buds also contained caffeic, p-coumaric, ferulic and isoferulic acids. Synapic acid and o- and m- coumaric acids were not detected in the extracts.

Loeschcke, V., and Francksen, H. 1964. [TRICHOCARPIN, A NEW PHENOLGLYCOSIDE IMPORTANT AS A RESISTANCE FACTOR, FROM POPLAR BARK.] Naturwissenschaften 51 (6), (140). 3 refs. [G.] O.R.S.
Its structure and fungistatic properties are briefly discussed.

Matsumoto, T., Nishida, K., Noguchi, M., and Tamaki, E. 1970. ISOLATION AND IDENTIFICATION OF AN ANTHOCYANIN FROM THE CELL SUSPENSION CULTURE OF POPLAR. Agr. Biol. Chem. 34 (7): 1110-1114.

Standifer, L.N., Devis, M., and Barbier, M. 1968. POLLEN STEROLS – A MASS SPECTOGRAPHIC SURVEY. Phytochemistry, Oxf. 7 (8), (1361-5). [19 refs. O.R.S.]
β-sitosterol was the principal sterol of Juniperus utahensis, Pinus sylvestris, Alnus glutinosa and Populus nigra var. italica, and cholesterol that of Populus fremontii.

Steele, J.W., and Bolan, M. 1972. PHYTOCHEMISTRY OF THE SALICACEAE. III. A GAS-LIQUID CHROMATOGRAPHIC PROCEDURE FOR THE IDENTIFICATION OF PLANT PHENOLS. J. Chromatography 71 (3): 427-434. Ref.

Reifer, I. 1967. PURIFICATION AND KINETIC PROPERTIES OF THE UREASE INHIBITOR COMPLEX FROM POPLAR LEAVES (POPULUS X BEROLINENSIS). Acta Soc. Bot. Polon. 36 (4), (725-34). [2 refs. [E.e.pol.] O.B.D.]

Steele, J.W., Ronald W., and Bolan, M. 1973. PHYTOCHEMISTRY OF THE SALICACEAE. (5). USE OF A GAS-LIQUID CHROMATOGRAPHIC SCREENING TEST TO DETECT PHYTOCHEMICAL VARIATIONS IN POPULUS DELTOIDES. (6) USE OF A GAS-LIQUID CHROMATOGRAPHIC SCREENING TEST FOR THE CHEMOTAXONOMY OF POPULUS SPECIES. Journal of Chromatography 84 (2) 309-314, 315-318 [E., 12 + 6 ref.] From Abstract Bulletin of the Institute of Paper Chemistry 44, 8608-9. LTP.

Tanase, I., Mocanu, V.V., and Chroitorescu, L. 1971. [BIOCHEMICAL ASPECTS OF THE HEALTHY BARK OF SOME POPLAR CLONES.] Rev. Padurilor 86 (1), [Ro.e.de.fr.ru., 6 ref.]
The contents of free sugars, free and bound (soluble protein) amino acids, and unsaturated fatty acids in bark of seven cultivars of Populus x canadensis and in P. nigra var. thevestina 'R. 103' were determined in the four seasons of the year. The results show wide differences between clones in the patterns of seasonal variation in the contents of metabolites, which may be the basis of clonal differences in resistance to fungal diseases of the bark.

Thieme, H., and Benecke, R. 1970. PHENOL GLYCOSIDES OF THE SALICACEAE. 7TH REPORT: THE GLYCOSIDE BEHAVIOUR OF NATIVE AND CULTIVATED POPULUS SPECIES IN CENTRAL EUROPE. Pharmazie, E. Berlin 25, (780-9). [De., 59 ref. From abstr. in Hort. Abstr. 1971 41 (3), (No. 7381).]

Thieme, H., and Benecke, R. 1971. [PHENOL GLYCOSIDES OF THE SALICACEAE. 8. GLYCOSIDE ACCUMULATION IN SOME POPULUS SPP. OF CENTRAL EUROPE.] Pharmazie, E. Berlin 26, (277-31). [19 ref. From abstr. in Hort. Abstr. 1971 41 (4), No. 9626.]
Glycoside contents were highest in the bark in Jan.-March and in the leaves in late May. Salicortin or tremulacin was the main glycoside in the leaves, and salicortin in the bark. Salicin, salireposide, nigracin and trichocarpin were also found.

Wasyl, Z., Bielanski, W., Jr., and Reifer, L. 1971. [PURIFICATION AND IDENTIFICATION OF THE INHIBITOR FROM POPLAR LEAVES.] Bulletin de l'Academie Polonaise des Sciences, Ser. Sci. Biol. 19, 9-15 From Berichte Biochemie und Biologie (1972) 347, 361. E. X.
The inhibitor isolated from the leaves of Populus X berolinensis has been identified as pyrocatechol.

Young, H. E., and Guinn, V. P. 1966. CHEMICAL ELEMENTS IN COMPLETE MATURE TREES OF SEVEN SPECIES IN MAINE. Tappi 49 (5), (190-7). [33 refs.]

160.2

Frison, G. 1969. SOME ASPECTS OF MINERAL NUTRITION OF POPLAR IN THE NURSERY; PRODUCTION OF DRY MATTER AND ABSORPTION OF NUTRIENTS. Cell Carta 20 (3): 28-34. [It.]

Pantosne, D. T. 1970. QUANTITATIVE ANALYSIS OF RELATIONSHIP AMONG THE QUANTITY OF N, P AND K TAKEN UP BY POPULUS "ROBUSTA" AND POPULUS "I-214", THEIR ASSIMILATION AND TRANSPIRATION AND GROWTH. Budapest Magyar Tud Akad Agrartud Osztalyanak Kozlemeny 29 (4): 579-596. [Hu.]

Sauter, J. J. 1967. [INVESTIGATIONS INTO THE CYTOCHEMICAL LOCALIZATION OF OXIDASES IN MICROSOMES OF DIFFERENT TISSUES OF POPULUS SPP.] Z. PflPhysiol, Stuttgart 57 (4), (352-67). [43 refs. [G.g.e.] 7 sets of photomicrographs. 3 tbls.]

Sekawin, M., and Frison, G. 1969. EFFECT OF STAND ON SOME PHYSICAL AND CHEMICAL PROPERTIES AND ON ROOTING OF POPLAR SAPLINGS. Cell Carta 20 (3): 46-50. [It.]

Wada, K., and Shibata, N. 1966. [PHYSIOLOGICAL STUDIES ON SOME TREE CLONES. (II). THE DIFFERENCE OF NITROGEN CONTENTS IN LEAVES, STEMS AND ROOTS OF SOME POPLAR CLONES.] Tech. Note Oji Inst. For. Tree Impr. No. 52. pp. [2] + smry. [Jap.e.]
A comparative study of Populus 'I-214', P. 'Oji NM-A' (clone selected from natural P. nigra x P. maximowiczii hybrids), P. 'Kambuchi' (artificial P. nigra x P. maximowiczii hybrid) and P. 'Oji M-6'. P_4 'I-214' had the largest N content in the leaves and the smallest in the stems.

160.21

Frison, G. 1969. DETERMINING MINERAL CONTENT OF THE POPLAR. Cell Carta 20 (6): 5-12. [It.]

160.22

Cadahia, D. 1965. [CLONAL PREFERENCES OF THE POPLAR WEEVIL, CRYPTORRHYNCHUS LAPATHI.] Bol. Serv. Plagas For., Madrid 8 (16), (115-25). [28 refs. [Span.span.e.] 8 photos. 2 tbls.]
Experiments showed definite preferences by C. lapathi for certain Poplar clones. Chemical analyses by thin-layer chromatography revealed the presence in these clones of an unidentified compound stimulating oviposition.

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Bohlmann, D. 1971. [THE PHYSIOLOGY OF TWIG ABSCISSION IN QUERCUS, POPULUS AND TILIA.] Allg. Forst- u. Jagdztg. 142 (8/9), (208-11). [De.e.fr., 10 ref.]
Short shoots at the lower end of Poplar branches abscissed after 3 weeks when all buds or leaves were removed, and occasionally if only the terminal bud remained, but partly stripped short shoots, and stripped second-order branches did not. Abscissed short shoots of Poplar contained the same amount of lipids, more Ca, K, Na and Al, but less P, than long shoots cut from the same branches, and showed no starch.

Borsdorf, W. 1967. [THE RELATIONSHIPS BETWEEN ASSIMILATION INTENSITY AND YIELD IN YOUNG PLANTS OF SOME POPLAR CLONES.] Zuchter 37 (6), (300-6). [21 refs. [G.g.e.] E.M.B.]
When 3- and 4-year-old Poplar hybrids (Sect. Aigeiros) were grown in containers, a negative correlation was found between intensity of assimilation per unit of leaf weight and total dry-matter production. Results of trials on three substrates showed that the highest assimilation per leaf unit occurred on the poorest soil (sand).

Cel'niker, Ju. L. [Editor.] 1967. SVETOVOJ REZIM, FOTOSINTEZ I PRODUKTIVNOST' LESA. [THE LIGHT REGIME, PHOTOSYNTHESIS AND PRODUCTIVITY OF THE FOREST.] Izdatel'stvo 'Nauka', Moscow. pp. 275. [Many refs. [Ru.].]

Chararas, C., and Chardenon, J. 1967. [OSMOTIC PRESSURE OF CELL SAP, AND THE ADAPTATION OF VARIOUS POPLARS TO THE ENVIRONMENT.] Bull. Serv. Cult. Etud. Peuplier et

Saule, Paris (1/2), (29-41). [F.]
Discusses promising use of osmotic pressure (o.p.) as an indicator of site suitability for and water requirements of various clones, and presents some representative o.p. values for comparable samples of foliage and bark of healthy and chlorotic individuals.

Charriere-Ladreix, Y. 1973. [STUDY OF THE FLAVONDID SECRETION OF POPULUS HIBRA L. VAR ITALICA BUDS: KINETICS OF THE SECRETORY PHENOMENA; ULTRASTRUCTURE AND DEVELOPMENT OF THE GLANDULAR TISSUE.] J Microsc (Paris) 17: 299-316. Ref. Eng. sum. [F.]

Chirkova, T. V. 1971. [ROLE OF NITRATE RESPIRATION IN ROOTS OF SOME WOODY SPECIES UNDER CONDITIONS OF TEMPORARY ANAEROBIOSIS.] Vestnik Leningrad. Univ. Biol. No. 4, p. 118-124 [Ru.e., 26 ref.] From Abstract Bulletin of the Institute of Paper Chemistry 44, 1067. LTP.
In continued studies nitrate respiration was investigated as a possible means of adaptation to oxygen deficiency, in rooted cuttings of Populus petrowskiana and Salix alba. In Poplar roots there was no change in nitrate content; the absorption of nitrates and the nitrate reductase activity were lowered.

Chirkova, T. V. and Gutman, T. S. 1972. PHYSIOLOGICAL ROLE OF BRANCH LENTICELS IN WILLOW AND POPLAR UNDER CONDITIONS OF ROOT ANAEROBIOSIS. Soviet Plant Physiol. 19 (2): 289-295. Ref.

Chirkova, T. V., and Gutman, T. S. 1972. [THE PHYSIOLOGICAL ROLE OF LENTICELS IN BRANCHES OF WILLOW AND POPLAR UNDER CONDITIONS OF ROOT ANAEROBIOSIS.] Fiziologiya Rastenii 19 (2) 352-359 [Ru.e., 22 ref. NLL]
Describes methods used to identify the volatile organic substances released via the lenticels of rooted shoots of Salix alba and Populus X petrowskiana grown with their roots in aerobic and anerobic conditions. In P. X petrowskiana the role of the lenticels is probably limited to oxygen supply.

Chirkova, T. V., and Petrova, V. N. 1971. [RESPIRATION AND METABOLISM OF ORGANIC ACIDS OF WILLOW AND POPLAR IN DEPENDENCE ON THE AERATION CONDITIONS.] Vestnik Leningrad. Univ., Biol. No. 3, 98-106 [Ru.e., 28 ref.] From Abstract Bulletin of the Institute of Paper Chemistry 43, 6932. LTP.
Considerable differences were observed in the response of the two species. The reduction in respiration rate resulting from anaerobiosis was greater and occurred sooner in Poplar than in the Willow, and increased activity of lactate and alcohol dehydrogenases was observed in Willow but not in Poplar.

Chirkova, T. V., and Razin'kova, M. S. 1970. ON THE PECULIARITIES OF RESPIRATION OF WILLOW AND POPLAR ROOTS DEPENDING ON DIFFERENT AERATION. Leningr. Univ. Vestnik Ser. Biol. 15 (3): 102-108. [Ru.]

Cirkova, T. V. 1968. [FEATURES OF THE OXYGEN SUPPLY OF ROOTS OF CERTAIN WOODY PLANTS IN ANAEROBIC CONDITIONS.] Fiziol. Rast. 15 (3), (565-8). [16 refs. [Ru.] A.P.B.]
Describes experiments on rooted shoots of Populus petrowskiana and Salix alba, proving that both the leaves and the lenticels participate in passing O to roots in anaerobic conditions.

Danilov, M. D. 1971. [SEASONAL GROWTH IN SURFACE AREA OF LEAF LAMINAE OF SOME WOODY SPECIES.] Lesoved. (4), (43-9). [Ru.e., 16 ref.]
Results of measurements of terminal-shoot growth in Populus balsamifera and Populus tremula.

Davies, C. R., and Warfing, P. F. 1965. AUXIN-DIRECTED TRANSPORT OF RADIOPHOSPHORUS IN STEMS. Planta 65 (2), (139-56). 25 refs. [E.e.g.] O.B.D.
Reports experiments with pea stems and Populus X robusta shoots. In girdled stems, acropetal transport of P^{32} to IAA-treated parts was much reduced, whereas a similar trend was shown for basipetal transport, it was not significant.

Digby, J., and Wareing, P. F. 1966. THE EFFECT OF APPLIED GROWTH HORMONES ON CAMBIAL DIVISION AND THE DIFFERENTIATION OF THE CAMBIAL DERIVATIVES. Ann. Bot., Lond. (n.s.) 30 (119), (539-48 + 1 plate). [22 refs. O.R.E.]
Indole-acetic acid (IAA) and gibberellic acid (GA) were applied to the cut ends of coppice shoots of Populus X robusta. High-IAA/low-GA concentrations favoured xylem formation whereas low-IAA/high-GA concentrations favoured formation of fully differentiated phloem.

Eidmann, F.-E., and Schwenke, H.-J. 1967. [DRY-MATTER PRODUCTION, TRANSPIRATION, AND ROOT RESPIRATION OF SOME IMPORTANT TREE SPECIES.] Forstwiss. Forsch. No. 23, pp. 46. [8 refs. [G.g.].]
Transpiration quotients (t.q.) and root-respiration quotients (r.q.), i.e. the amounts, respectively, of water transpired and CO_2 exhaled per g. dry matter produced, were studied on different Poplar varieties and other species. Poplars had comparatively high t.q.'s and low r.q.'s.

Frolova, G. D. 1965. [PARTHENOCARPY IN BETULA, POPULUS AND ROBINIA PSEUDOACACI.]) Bot.Z. 50 (3), (394-6). 6 refs. [Ru.] 1 tbl.
It apparently occurs only when the tree possesses an adequate stock of 'plastic' reserve substances.

Furukawa, A. 1972. PHOTOSYNTHESIS AND RESPIRATION IN POPLAR PLANT. Journal of the Japanese Foresty Society 54 (3), 80-84 [E.jap., 21 ref.]
Release of CO_2 into CO_2-free air was inhibited at low light intensities in a manner similar to the observed in different species by other workers. The highest value of apparent photosynthesis was recorded at 20 000 lux and 25°C, and the maximum rate of CO_2 emission in the light was observed at 30°C. Increasing water stress had a similar, adverse effect on both apparent photosynthesis and CO_2 emission in the light.

Heine, R. W. 1970. ABSORPTION OF PHOSPHATE AND POTASSIUM IONS IN POPLAR STEMS. J. exp. Bot. 21 (67), (497-503). [12 refs. O.B.D.]

Kazarian, V. O., and Chilingarian, A. A. 1972. ON THE EFFECT OF PRUNING ON THE RATE OF CHANGE OF CERTAIN PHYSIOLOGICAL INDICES OF LEAVES OF POPULUS. Tr. Bot. Inst. Akad. Nauk Arm. SSR 18: 73-79. Ref. [Ru.].

Khashes, Ts. M. 1971. [PHYSIOLOGY OF THE DIURNAL RHYTHM OF TRANSPIRATION OF WOODY PLANTS.] Ekologiya (6), (28-32). [Ru. NLL.]
The mid-day drop in transpiration rate was correlated with the diurnal changes in the contents of free and bound water, assimilation products and mineral composition of the leaves of trees on the different margins.

Koch, W. 1969. [THE EFFECTS OF CO_2 ON PHOTOSYNTHESIS IN SOME WOODY SPECIES IN LABORATORY CONDITIONS.] Flora, Jena 158 B (4/5), (402-28). [G. 28 refs. O.B.D.]
Results showed that optimum net assimilation depends on CO_2 concentration. When P. sylvestris is subjected continuously to high CO_2 concentrations, a gradual decrease in photosynthesis takes place, though this effect can be avoided by the use of a natural light/dark rhythm.

Kohut, R. J. 1972. RESPONSE OF HYBRID POPLAR TO SIMULTANEOUS EXPOSURE TO OZONE AND PAN. M. S. Thesis. The Pennsylvania State University, p. 26.

Larsen, C. M. 1968. [THE RELATIONSHIP BETWEEN SEX AND GROWTH IN THE GENUS POPULUS.] Dansk dendrol. Arsskr. 3 (1), (45-52). [12 refs. [Dan.f.].]
A study on a Polish provenance of P. tremula, and on P. deltoides, P. deltoides X P. trichocarpa and P. nigra, grown from seed, shows that there is apparently no general relationship between sex and growth rate. The sex ratio is generally 1:1.

Leach, R. W. A., and Wareing, P. F. 1967. DISTRIBUTION OF AUXIN IN HORIZONTAL WOODY STEMS IN RELATION TO GRAVIMORPHISM. Nature, Lond. 214 (5092), (1025-7). [15 refs.]
It is concluded that the lesser cambial activity on the lower side may be explicable in terms of the greater content of inhibitory substances.

Luukkanen, O., and Kozlowski, T. T. 1972. GAS EXCHANGE IN SIX POPULUS CLONES. Silvae Genetica 21 (6) 220-229 [E.de., 32 ref.]

Lyr, H., et al. 1968. [THE DIORNAL GROWTH RHYTHM OF WOODY SPECIES.] Flora, Jena 157B (4), (615-24). [7 refs. [G.g.e.] O.B.D.]
In general, maximum growth took place between 9 a.m. and 3 p.m., and minimum growth between 11 p.m. and 2 a.m.

Makedonska, C., and Delkov, N. 1968. [SEASONAL CHANGES IN THE MOISTURE DEFICIT, CELL-SAP CONCENTRATION, CATALASE ACTIVITY AND DRY MATTER IN THE LEAVES OF CERTAIN POPLARS.] Nauc. Trud. Lesoteh. Inst., Sofija (Ser. Gorsko Stop.) No. 16, (67-74. [6 refs. [Bulg.ru.g.].]

Makedonska, T. [C.], and Yordanov [Jordanov], I. 1969. SEASONAL CHANGES IN THE INTENSITY AND PRODUCTS OF PHOTOSYNTHESIS IN SOME POPLARS. C. R. Acad. Bulg. Sci 22 (9), (1075-8). [E. 3 refs. E.M.B.]
Taking the growing season as a whole, Populus deltoides var. monilifera had the highest rate of photosynthesis, followed by P. X robusta; P. X scrotina, P. 'I-214' and P. 'Sacran 79' had fairly similar rates of photosynthesis.

Maksaeva, L. D. 1970. [TRANSPIRATION OF POPLARS IN PLATEAU CONDITIONS IN THE MIDDLE DON REGION.] Lesn. Z. 13 (3), (152-4). [Ru.]

Maruyama, K., and Teshima, T. 1972. [ECOLOGICAL STUDIES OF NATURAL BEECH [FAGUS CRENATA] FOREST. 29. COMPARATIVE STUDIES ON THE RATES OF PHOTOSYNTHESIS AMONG THE DIFFERENT JAPANESE BROAD-LEAVED TREE SPECIES (I).] Niigata Agricultural Science No. 24, 31-42 [Jap.e., 21 ref.]
Photosynthetic capacity appeared to be characteristic of particular genera and families; a relatively high capacity was characteristic of Populus, Salix, Alnus and Robinia.

Miller, P. C. 1966. LEAF TEMPERATURE PROFILES IN VEGETATION CANOPIES IN WEST-CENTRAL COLORADO. Abstr. in Bull. Ecol. Soc. Amer. 47 (4), (198). [E.M.B.]
By day, leaves of Oak were further above air temperature than those of Aspen, and by night they were warmer than Aspen leaves. Differences in the temperature profiles of the two species are related to the amount and distribution of leaves in the canopy.

Nitsch, J. P., and Nitsch, C. 1965. [PRESENCE OF A PHYTOKININ IN THE CAMBIUM.] Bull. Soc. Bot. France 112 (1/2), (1-10 + 1 plate). 14 refs. [F.e.] 7 sets of gphs.
A phytokinin was extracted with methanol from the cambial region of a 20-year-old Populus x robusta felled during the active growing period. There were also indications of auxins in the extracts.

Outer, R. W. Den 1973. CYTOLOGIC INVESTIGATIONS ON THE AXIAL-PARENCHYMA AND ON THE RAY-PARENCHYMA OF THE SECONDARY PHLOEM OF POPULUS. Zeitschrift fur Pflanzenphysiologic 70 (3) 266-269 [E., 15 ref, OBD]
Starch content reach a maximum in Aug.-Sept. and a minimum in Dec.-Jan., and was inversely correlated with phosphatase activity. Fat was always present but reached a minimum during June and July.

Polster, H. 1966. [RUSSIAN RESEARCH IN PLANT PHYSIOLOGY AIMING AT RAISING FOREST PRODUCTIVITY.] Sozial. Forstw., Berl. 16 (4), (121-4). 1 ref. [G.]

Rasmussen, R. A. 1972. WHAT DO THE HYDROCARBONS FROM TREES CONTRIBUTE TO AIR POLLUTION? Journal of the Air Pollution Control Association 22 (7) 537-543 [E., 26 ref NLL]

Reifer, I., Ber, E., and Kleczkowski, K. 1970. INHIBITION OF UREASE BY "COINHIBITOR" ISOLATED FROM POPLAR LEAVES (POPULUS HEROLINENSIS). Acad. Polon Sci. Bull. Ser. Sci. Biol. 18(10): 599-602.

Sauter, J. J. 1966. [THE PHYSIOLOGY OF POPLAR WOOD RAYS. I. SEASONAL COURSE OF STARCH ACCUMULATION IN WOOD RAY PARENCHYMA.] Z. PflPhysiol., Stuttgart 55 (3), (246-58). [36 refs. [G.g.e.] O.B.D.]
Seasonal changes in starch content were studied microscopically in different parts of the stem of 8-year-old Poplars. Eight different seasonal changes were found.

Sauter, J. J. 1966. [THE PHYSIOLOGY OF POPLAR WOOD RAYS. II. SEASONAL CHANGES IN PHOSPHATASE ACTIVITY IN WOOD RAY PARENCHYMA AND ITS POSSIBLE SIGNIFICANCE FOR CARBOHYDRATE METABOLISM AND THE TRANSLOCATION OF ASSIMILATES.] Z. PflPhysiol., Stuttgart 55 (3), (349-62). [32 refs. [G.g.e.] O.B.D.]
There was an unexpectedly high acid-phosphatase activity during dormancy, a marked increase during the starch mobilization period in early spring, a decrease during starch deposition in summer, and a second increase during starch dissolution in late autumn and winter.

Sauter, J. J. 1966. [SEASONAL CHANGES IN WATER CONTENT AND TRANSLOCATION IN HEARTWOOD AND SAPWOOD OF POPULUS.] Holzforschung, Berlin 20 (5), (137-42). [21 refs. [G.g.e.] P.R.]
Increment cores taken in an 8-year Black Poplar hybrid clone were analysed. Heartwood showed a clear moisture content maximum in spring and another in autumn and, except during bud swelling, had higher moisture content that sapwood.

Sauter, J. J., and Marquardt, H. 1965. [PHOSPHATASE ACTIVITY AND TRANSLOCATION OF MATERIALS IN RAY PAREUCHYMA OF POPULUS.] Naturwissenschaften 52 (3) (67-8). 13 refs. [G.] O.R.S.

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Among 4 clones, growth was best at pH 5 or 6.

Siwecki, R., Kozłowski, T. T. 1972. TRANSPIRATION AND LEAF ANATOMY OF SIX POPULUS CLONES. American Journal of Botany 59 (6, Part 2) 670 [E., OBD]
Wide variations were found in the water loss, internal leaf anatomy, stomatal size, stomatal frequency and control of stomatal aperture in leaves of 6 Poplar clones.

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Szendrey, I. 1965. [INVESTIGATIONS ON P DISTRIBUTION IN POPLAR BY MEANS OF RADIOACTIVE P.] In Izotopok alkalmazasa a mezogazdasagi kutatasban. Orszagos Atomenergia Bizottsag Mezogazdasagi Izotopalkalmazasi Szakbizottsaga, Budapest. pp. 252-8. [Hu.]
Experiments suggest that disturbances of sap circulations cause an uneven distribution of P in the tree.

Tatsumi, S. 1964. [CALCIUM METABOLISM IN THE TREES. I. UPTAKE AND TRANSPORT OF CALCIUM IN POPLAR CUTTINGS.] J. Jap. For. Soc. 46 (7), (242-5). 4 refs [Jap.jap.e.]
Ca moved rapidly in stems but much slower in leaves and petioles,

and tended to concentrate in the middle leaves and petioles, which showed the largest accumulation.

Tatsumi, S. 1964. [CALCIUM METABOLISM IN THE TREES. II. THE EFFECTS OF THE TEMPERATURE ON THE ASCENT OF CA IN POPLAR CUTTINGS.] J.Jap. For. Soc. 46 (10), (325-35). 8 refs. [Jap.jap.e.e.]
Comprehensive data are given on variations in the movement of Ca from the wood into the leaf, via the bark and petiole.

Vasilenko, I.D. 1972. [DIAGNOSIS OF SEX IN POPLAR SEEDLINGS WITH THE AID OF BIOCHEMICAL REACTIONS.] Lesnoi Zhurnal 15 (1) 141-142 [Ru., 2 ref.]
Kulik's reagent (1) consists of a 5% soda solution plus 10% lead acetate; Nekrasov and Ostapenko's reagent (2) consists of an alcohol solution of benzidine plus 5% H_2O_2. Reagent (1) distinguished the sexes in more cases than (2), and is therefore preferred.

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A collection of 34 papers presented at a conference in 1962, including: Development and structure of the embryo sac of Populus alba (Z. P. Kos; Vegetative and seed progeny of Poplar plustrees (N.N. Peelina). Control of Sciapteron tabaniforme in hybrid Poplar plantations (G. A. Timeenko): Phytopathological evaluation of Poplar hybrids (A. V. Lesovskij).

Anonymous. 1968. NOTES ON THREE NEW [POPLAR] CLONES IN THE PERIOD OF SELECTION. Transl. Dep. For. Can. No. 204, pp. 3 [Transl. from An. Inst. For. Invest. Exp., Madrid 1963 35 (8), (53-5).

Anonymous. 1969. TREE BREEDING AND FOREST GENETICS IN CANADA. For. Chron. 45 (6), (375-448). [Many refs.]

Anonymous. 1970. [GENETICS AND TREE BREEDING.] Lesnictvi 16 (3), (221 . . . 279). [Cs.ru.du.f., many ref.]
A special issue containing, in addition to articles abstracted separately, gene interaction in Poplar hybrids (G. Vincent and M. Polnar).

Anonymous. 1971. [POPLAR-GROWING IN QUEBEC. I. POPLAR BREEDING. II. DEVELOPMENT OF POPLAR-GROWING.] Rapport, Conseil de la Recherche et du Developpement Forestiers du Quebec No. 1, xi + 56 pp. [Fr., 7 ref.]
Describes research on Poplar breeding, gives a list of tested clones now available in Quebec with recommendations for their use in reforestation, and recommends large-scale commercial planting of Poplar in the province.

Avanzo, E. 1974. [POSSIBILITY OF GENETIC IMPROVEMENT, FOR DRY-MATTER PRODUCTION WITH CLOSELY SPACED PLANTATIONS ON SHORT ROTATIONS, IN POPLARS OF SECTION AIGEIROS.] Cellulosa e Carta 25 (9) 22-27 [It.f.e.du., 4 ref.]

Avanzo, E. 1974. [RELATIVE IMPORTANCE OF BASIC DENSITY AND BASAL AREA IN THE SELECTION OF CLONES OF POPLAR OF SECTION AIGEIROS.] Cellulosa e Carta 25 (10) 29-39 [It.f.e.du., 9 ref.]
Describes a study of 500 Populus deltoides, 144 P. nigra and 73 P. X euramericana [P. X canadensis] clones. In two-year-old plots of each clone the mean b.a. (a), basic density of the b.-h. disk from the mean stem of each plot (b), and the weight index (c) (product of (a) X (b)) were calculated.

Bartkowiak, S., and Bialobok, S. 1965. [THE RATIO OF STEM DIAMETER TO HEIGHT IN POPLAR HYBRIDS, AS AN INDEX FOR SELECTION OF HETEROTIC INDIVIDUALS.] Arboretum Kornickie, Poznan 10, (175-81). 4 refs. [Pol.ru.e.e.]
It appears that differentiation of the best and worst growing trees on the basis of this ratio does not become possible until the age of 5-7 years. Only then can the ratio be used for selection purposes, when it is more informative than height or diameter alone.

Brayshaw, T. C. 1965. NATIVE POPLARS OF SOUTHERN ALBERTA AND THEIR HYBRIDS. Publ. Dep. For. Can. No. 1109, pp. 40 + 1 map. [17 refs. [E.e.f.].]
No direct hybrids between P. tremuloides and the section Tacamahaca were found, but other possible combinations were. Several individuals showing admixtures of characters of three species were found. Populus X andrewsii appears to be a product of crossing between P. deltoides var. occidentalis and P. tremuloides.

Brunkener, L. 1974. A REVIEW OF METHODS FOR THE PRODUCTION OF HAPLOIDS IN SEED PLANTS. Rapporter och Uppsatser, Institutionen for Skogsgenetik No. 13, 36 pp. [E.sv., 115 ref.]

Castellani, E., and Prevosio, M. 1969. EFFECTS OF RESEARCH ON THE ECONOMY OF POPLAR CULTURE. [Pap.] 2nd FAO/IUFRO World Consult. For. Tree Breed., Washington 1969 No. FO-FTB-69-13/4, pp. vi + 11. [16 refs. [E.e.f.].]
Gives a short historical review of research at the Italian Poplar Institute at Casale Monferrato on Poplar breeding and the development of economic silvicultural techniques for use in Poplar growing.

Chardenon, J. 1968. [A VERY PROBABLE CASE OF BUD MUTATION IN POPLAR.] Rev. for. franc. 20 (1), (33-7). [5 refs. [F.].]

Chiba, S. 1966. [STUDIES ON THE TREE IMPROVEMENT BY MEANS OF ARTIFICIAL HYBRIDIZATION AND POLYPLOIDY IN ALNUS AND POPULUS SPECIES.] Bull. Oji Inst. For. Tree Impr. Kuriyama, Hokkaido No. 1, pp. 165. [101 refs. [Jap.jap.e.e.].]
A detailed, fully illustrated account of studies on the production of improved Alders (1) and Poplars (2) for timber and pulpwood in Japan

Chmielewski, W. 1969. [HYBRID POPLARS PRODUCED AT THE POLISH FOREST RESEARCH INSTITUTE AND THEIR PRELIMINARY EVALUATION.] Prace Inst. Bad. Lesn. No. 372, pp. 112. [Pol.ru.e., 127 refs.]
Reviews work at the Institute since 1953, mainly on Poplars of sections Leuce and Aigeiros.

Chung, S. B., and Son, D. S. 1972. INTER AND INTRA-SPECIES HYBRIDIZATION IN POPLARS. LIST OF HYBRID POPLARS (II). Research Report of the Forest Genetics Institute, Korea No. 9 97-111 [E.kor., 1 ref.]
Gives tabulated data on the 313 Poplar crosses made at Suwon between 1961 and 1970, including information on the location of the ♀ parent and the origin of the pollen, the year the cross was made, the number of seedlings produced and the relative growth rate of the progeny.

Dawson, D. H., 1974. RUST RESISTANCE OF POPULUS CLONES COMPARED IN WISCONSIN STUDY. Tree Planters' Notes 25 (1):16-18 [E., 41 ref.].
In general, there was greater variability within than between species or taxonomic groupings, 31 clones did not show susceptibility until the end of the growing season, and the degree of rust infection was not always related to growth rate.

Dragavcev, V. A. 1969. ON THE POSSIBILITY OF ELIMINATING THE INTER-INDIVIDUAL 'ENVIRONMENTAL' COMPONENT OF VARIANCE FOR THE PURPOSE OF A MORE CORRECT ESTIMATION OF THE RECURRENCE COEFFICIENT IN PLANTS. Genetika, Moskva 5 (2):(30-5). [[Ru.] From abstr. in Plant Breed. Abstr. 1969 39 (4), (No. 7637).]
It is shown that the environmental component can be eliminated by aligning it with some background character that is correlated ecologically with the character selected and has a heritability coefficient approaching zero.

Gancev, P. 1965. [INTERSPECIFIC HYBRIDIZATION OF CERTAIN SPECIES OF POPULUS.] In Simpozium po otdalennoj gibridizacii rastenij Sofija 10-12 Nojabrja 1964. Izdatelstvo Bolgarskoj Akademii Nauk, Sofia. pp. 263-74. 10 refs. [Ru.e.] A.P.B.
Reports findings from 35 crossing combinations among 12 Poplars in the sections Aigeiros, Tacamahaca and Leuce.

Gancev, P. 1968. [ANATOMICAL CHANGES IN POPLAR LEAVES AND PETIOLES AS A SPECIFIC MANIFESTATION OF HYBRIDIZATION.] Gorskostop. Nauka, Sofija 5 (6), (23-39). [13 refs. [Bulg.ru.e.].]
Anatomical differences were confirmed between Populus nigra var, thevestina (1), P. simonii (2), P. tacamahoca (3), P. alba (4), and P. tremula (5), and between the hybrids (1) X (2), (4) X (5), (3) X (4), and (3) X (2).

Ganchev, P. 1972. [STUDIES ON HYBRID VARIATION IN CERTAIN POPLARS.] Gorskostopanska Nauka 9 (2) 21-30 [Bulg.ru.e., 13 ref.]
An analysis of variation in leaf dimensions, height and diameter in a number of Poplar species and F_1 hybrids, mainly Populus nigra var. thevestina X P. simonii var. fastigiata and P. alba X P. tremula.

Gerhold, H. D., et al. [Editors] 1966. BREEDING PEST-RESISTANT TREES. Pergamon Press, Oxford. pp. ix + 505. [Many refs. (Proceedings of a N.A.T.O. and N.S.F. advanced study institute on genetic improvement for disease and insect resistance of forest trees, University Park, Pa., 1964).]

Giordano, E. 1973. [THE GENETIC IMPROVEMENT OF POPLAR, WITH PARTICULAR REFERENCE TO THE USE OF NATURAL SPECIES AND FORMS.] Annali, Accademia Italiana di Scienze Forestali 22, 159-181 [It.f., 81 ref.]
Examines the importance of Poplar breeding for faster growth and greater disease resistance both in Europe and the USA, and gives reasons for the selection and widespread distribution of Populus X euramericana [P. X canadensis] clones in Italy.

Grosscurth, W. 1972. [SITE REQUIREMENTS AND CHOICE OF CULTIVARS OF POPLARS OF THE SECTIONS AIGEIROS, LEUCE, AND TACAMAHACA.] Holzzucht 26 (¾) 21-30 [De.]

Hattemer, H. H. 1967. [VARIATIONS IN TREE HEIGHT, D.B.H. AND MORTALITY IN A SERIES OF FIELD TRIALS WITH HYBRID BLACK POPLAR CLONES.] Silvae Genet 16 (5/6), (153-62). [15 refs. [G.g.e.].]

Hyun, S. K., Son, D. S., and Cho, R. M. 1967. [THE GROWTH PERFORMANCE OF P. ALBA X P. GLANDULOSA F_1 HYBRID.] Res. Rep. Inst. For. Genet., Suwon No. 5, (53-60). [15 refs. [Kor.kor.e.e.].]

Jokela, J. J. 1964. BREEDING IMPROVED VARIETIES OF EASTERN COTTONWOOD [POPULUS DELTOIDES]. Illinois Research, Urbana 6 (2), (6-7). C.G.B.
Four-year results indicate significant differences for 8 of 9 traits studied, especially in the seedling populations, southern provenances making the best growth.

Jovancevic, M. 1965. [INTERNATIONAL [IUFRO] MEETING ON FOREST GENETICS IN JUGOSLAVIA (ZAGREB).] Sum. List 89 (11/1 2), (595-606). [Serb.]

Keres[z]tesi, B. 1968. FOREST TREE IMPROVEMENT IN HUNGARY. Unasylva 22 (1), (14-7).

Keresztesi, B. 1969. SELECTION OF FOREST TREES AND SHRUBS FOR IMPROVEMENT OF BEE-PASTURES AND IN FAVOUR OF LANDSCAPE ARCHITECTURE. [Pap.] 2nd FAO/IUFRO World Consult. For. Tree Breed., Washington No. FO-FTB-69-6/5, pp. 8 + smries. [E.e.f.span.]

Keresztesi, B. 1971. FOREST TREE IMPROVEMENT IN HUNGARY. Erdeszeti Kutatasok 67 (2) 5-28 [E., 13 ref.]

Kopecky, F. 1971. HISTORY, PRESENT STATE AND FUTURE TASKS OF POPLAR BREEDING IN HUNGARY. Erdeszeti Kutatasok 67 (2) 29-53 [E., 48 ref.]

Kosichenko, N. E., and Shirnin, V. K. 1973. [EARLY DIAGNOSIS OF THE QUALITY OF POPLAR WOOD ON THE BASIS OF ITS STRUCTURE.] Lesovedenie No. 6, 78-83 [Ru.e., 10 ref.]
Describes comparative anatomical studies made on 1-year shoots of 14 species and hybrids, demonstrating the possibilities of early selection for specific uses on the basis of fibre length and basic density.

Li, W.-Y., et al. 1965. [BREEDING OF POPLAR FOR RESISTANCE TO LEAF-RUST.] Sci. Silvae, Peking 10 (1), (37-49). 15 refs. [Chin.chin.e.] N.L.L.
Selection was made among 46 Poplars for rust resistance.

Luukkanen, O. 1972. [GENETIC VARIATION OF PHOTOSYNTHESIS IN FOREST TREES.] Silva Fennica 6 (2) 63-89 [Fi.e., 143 ref.]
Presents an extensive review of the literature and some account of the author's (hitherto unpublished) work on the genetic variation of photosynthesis in Poplars.

Meiden, H. A. van der. [n.d.] [THE PROFITABILITY OF BREEDING RESEARCH ON POPLAR.] Ned. Bosb. Tijdschr. 43 (7/8), (161-6). [Nl.e., 4 ref.]
Research on Poplar breeding in Holland at present costs ca. 100,000 guilders per year, while the increase in yield to be expected from the introduction of new fast-growing clones is estimated at 5½ million guilders per year.

Muhle Larsen, C. 1970. RECENT ADVANCES IN POPLAR BREEDING. Int. Rev. For. Res. 3,(1-67). [12 pp. of refs.]

Nikanorov, G. M. 1970. [SOME RESULTS OF POPLAR BREEDING IN MOLDAVIA.] Sb. Rabot. po Lesn. Khoz. Mold. Lesn. Opyt. St. (5),(33-52). [Ru. From abstr. in Referat.Zh. (4.56.101). Ru. NLL]

Panetsos, C. P. [K. P.] 1967. [ARTIFICIAL HYBRIDS BETWEEN THE NATIVE POPULUS NIGRA VAR, PUBESCENS AND INTRODUCED SPECIES AND CLONES.] [Publication,] Forest Research Institute, Ministry of Agriculture, Athens No. 18, pp. 44 + 13 figs. [30 refs. [Gk.gk.e.e.].]

Panetsos, C. P. [K. P.] 1969. QUALITY CHARACTERS IN POPULUS. [Pap.] 2nd FAO/IUFRO World Consult. For. Tree Breed., Washington 1969 No. FO-FTB-69-3/3, pp. 5. [9 refs. [E.e.].]
Reviews the mechanism of inheritance of certain morphological and growth characters, with special reference to recent hybridization studies in Greece.

Panetsos, C. P., and Kailidis [Kailides], D. S. 1969. [THE INHERITANCE OF RESISTANCE OF POPLARS TO GYPSONOMA ACERIANA AND PHYLLOCNISTIS SUFFUSELLA.] Anz. Schadlingsk. 42 (1), (7/8). [13 refs. [G.g.e.].]
The resistance was studied of some F_1 Poplar hybrids, their parents and various clones commonly cultivated in Greece, to G. aceriana, and to the less important nursery pest P. suffusella. Resistance to both pests appeared to be genetically controlled.

Pohl, Z. 1964. [INHERITANCE OF PYRAMIDAL CROWN FORM IN HYBRIDS OF POPULUS PYRAMIDALIS [P. NIGRA VAR. ITALICA].] Arboretum Kornickie, Poznan 9, (199-222). 19 refs. [Pol.e.ru.]

Pohl, Z., and Stecki, Z. 1965. [INHERITANCE OF SOME MORPHOLOGICAL LEAF CHARACTERS IN HYBRIDS OF POPULUS 'ANGULATA CORDATA'.] Arboretum Kornickie, poznan 10, (145-67 + 2 tbls.). 19 refs. [Pol.e.ru.]
A biometric study was made of ca. 10,000 leaves from hybrids produced by crossing P. 'Angulata cordata' ♀ with (a) P. nigra var. italica, (b) P. X berolinensis, and (c) P. laurifolia. In all the hybrid progenies, P. 'Angulata cordata' was dominated by the ♂ parent. Morphological characters of (a) were inherited most, and those of (c) least strongly.

Polk, R. B. (Editor) 1974. PROCEEDINGS OF THE EIGHTH CENTRAL STATES FOREST IMPROVEMENT CONFERENCE, OCTOBER 11-13, 1972, COLUMBIA, MISSOURI. USA; School of Forestry, Fisheries and Wildlife, University of Missouri. 96 pp. [E., many ref.]
Includes comparison of Poplar [Populus spp.] clone performance in Nebraska (W.T. Bagley, 13 ref.)

Pryor, L. D., and Willing, R. R. 1965. THE DEVELOPMENT OF POPLAR CLONES SUITED TO LOW LATITUDES. Silvae Genet. 14 (4), (123-7). 7 refs. [E.e.f.g.]

Reck, S. 1973. [SOME CHARACTERISTICS OF THE WOOD OF POPULUS TRICHOCARPA COMPARED WITH THAT OF BLACK POPLAR HYBRID VARIETIES.] Holzzucht 27 (1) 6-8 [De.e., 10 ref.]

Rohmeder, E., and Schonborn, A. von. 1965. [THE INFLUENCE OF ENVIRONMENT AND HEREDITY ON THE RESISTANCE OF FOREST TREES TO AIR POLLUTION BY INDUSTRIAL GASES. THE BREEDING OF A RELATIVELY SMOKE-RESISTANT VARIETY OF SPRUCE.] Forstwiss. Cbl. 84 (1/2). (1-13). 9 refs. [G.g.]
Comparison with 18 other coniferous and broadleaved species exposed to moderate gas concentrations (1 mg. SO_2 or 0.1 mg. F/cu.m.) showed that Norway Spruce, Larch and Douglas Fir were particularly susceptible and Oak and Poplar resistant.

Ronald, W. G., and Steele, J. W. 1974. BIOSYSTEMATICS OF THE GENUS POPULUS. III. NATURALLY OCCURRING MANITOBA HYBRIDS OF INTRODUCED P. X PETROWSKYANA WITH NATIVE P. DELTOIDES VAR. OCCIDENTALIS AND P. BALSAMIFERA. Canadian Journal of Botany 52 (8) 1883-1887 [E.f., 9 ref. Cf. FA 36, 112. ORS]

Rose, D. W. 1974. [SELECTION OF CLONES FOR INTENSIVE CULTIVATION.] Silvae Genetica 23 (6) 193-199 [De.e., 18 ref.]
Discusses merits of cluster-analysis techniques as a labour-saving method of selecting clones of woody species suitable for short rotation coppice crops.

Rovskij, V. M. 1966. [RESULTS AND PROSPECTS IN THE BREEDING AND SELECTION OF FOREST TREES AND SHRUBS IN SOVIET CENTRAL ASIA.] Trudy Sredneaziaticeskogo Naucno-Issledovatel'skogo Instituta Lesnogo Hozjajstva 1966 (10), (162-79). [Ru.] From abstr. in Referat. Z., Moskva (9.56.81). [Ru.] I.F.B.

Schlosser, L.-A. 1969. [MARSSONINA-RESISTANCE OF A POPULATION OF TETRAPLOID POPLARS.] Silvae Genet. 18 (5/6), (192-4). [G.e., 8 refs.]
During an outbreak of M. brunnea, 95% of a tetraploid population of greater than 200 individuals, resulting from open population of 'Oxford' and 'Rochester X Androscoggin' hybrids, proved to be completely resistant.

Schreiner, E. J. 1964. IMPROVEMENT OF DISEASE RESISTANCE IN POPULUS. In Proc. FAO World Consult. For. Genet., Stockholm 1963 No. 6a/2 pp. vi + 21. 85 refs. [E.e.f.span.]
Mainly a review of world literature.

Schreiner, E. J. 1974. POPLARS CAN BE BRED TO ORDER FOR MINI-ROTATION FIBER, TIMBER AND VENEER PRODUCTION AND FOR AMENITY PLANTINGS. In Proceedings, 21st Northeastern Forest Tree Improvement Conference. 85-96 [E., 9 ref.]

Sekawin, M. 1972. [THE EARLY SELECTION OF POPLARS AS REGARDS GROWTH.] Cellulosa e Carta 23 (8) 35-44 [It.f.e., 1 ref.]
Coefficients of correlation were computed between the diameters of Poplar saplings in the nursery at Casale Monferrato and their girths at different ages in the experimental Poplar plantation. The correlation varied from moderate to good in spite of lack of uniformity in the soil and other factors.

Skulov, G. G., and Genze, G. I 1970. [NEW POPLAR AND WILLOW HYBRIDS.] Materialy Nauen. Geogr. Konf. Omsk. Otd. Geogr. Obsc. SSSR, Omsk (62-70). [Ru. From abstr. in Referat. Z. 1970 (11.56.118). Ru. N.L.L.]
Lists three Willow hybrids and two Poplar hybrids produced at Omsk and considered promising for amenity planting.

Steenackers, V. 1969. [THE PRESENT STATE OF THE SELECTION AND BREEDING OF POPLAR CLONES RESISTANT TO THE VARIOUS DISEASES.] [Pap.] 2nd FAO/IUFRO World Consult. For. Tree Breed., Washington 1969 No. FO-FTB-69-9/4. pp. 17. [6 pp. of refs. [F.f.e.].]
Reviews the literature on research since 1963, and discusses Populus nigra, P. deltoides, P. trichocarpa, P. maximowiczii and their hybrids, with special reference to Aplanobacterium populi, Dothichiza populea, Marssonina brunnea, virus diseases, etc.

Steenackers, V. 1974. [POPLAR CULTIVATION NOW. 1, 2 & 3.] Populier 11 (2; 3; 4) 29-32; 49-51; 65-68 [Nl]
Gives an account of the importance of Poplar cultivation in Belgium, France, Holland and Italy; the origin of various clones and spontaneous hybrids; the development of monoclonal cultivation; the improvement of Poplars by breeding (with special reference to Populus nigra, P. deltoides, P. trichocarpa and P. maximowiczii); and the creation and selection of clones resistant to various diseases.

USDA Forest Service. 1968. PROCEEDINGS OF THE EIGHTH LAKES STATES FOREST TREE IMPROVEMENT CONFERENCE. U.S. For. Serv. Res. Pap. NC-23, 60 p. Nth Cent. For. Exp. Sta. [Many refs.]
Includes wood property variation in Populus and stem anatomy variation in Cottonwood growing under nutrient-deficient conditions.

USDA Forest Service. 1973. JOINT PROCEEDINGS OF THE TENTH LAKE STATES FOREST TREE IMPROVEMENT CONFERENCE AND THE SEVENTH CENTRAL STATES FOREST TREE IMPROVEMENT CONFERENCE, SEPTEMBER 22-24, 1971. USDA Forest Service General Technical Report NC-3, 61 pp. North Central Forest Experiment Station [E. many ref.]
Emphasizes improvement of pulpwood yields from Populus deltoides, Aspen, other hardwoods.

USDA Forest Service. 1973. PROCEEDINGS, 20TH NORTHEASTERN FOREST TREE IMPROVEMENT CONFERENCE, University of New Hampshire, Durham, N. H., July 31-August 2, 1972. Upper Darby, Pa., USA, Northeastern Forest Experiment Station. 177 pp. [E., many ref.]
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Vasil'ev, A. E. 1964. [SOME ASPECTS OF THE BIOLOGY OF PLANT CHIMAERAS.] Bjull. Glavn. Bot. Sada, Moskva No. 54, (20-6). 20 refs. [Ru.ru.] N.L.L.

Vasil'ev, A. E. 1965. [INDUCED INVERSION OF COMPONENTS IN PERICLINAL POPLAR CHIMAERAS.] Dokl. Akad. Nauk. SSSR 164 (6), (1401-4). [11 refs. [Ru.] N.L.L.]

Vincent, G., and Polnar, M. 1970. [GENE INTERACTION IN POPLAR HYBRIDS.] Lesnictvi 43 (3):221-233. [Cz.]

Vincent. G., and Polnar, M. 1970. [HETEROSIS EFFECTS IN POPLAR HYBRIDS.] Silvae Genet. 19 (2/3), (69-73). [G.e.]

Vincent, G., and Polnar, M. 1971. [THE INTERACTION OF NON-ALLELOMORPHIC GENES IN POPLAR HYBRIDS.] Silvae Genet. 20 (5/6), (214-8). [De.e., 9 ref.]
Results indicate that in populations of double crosses it is possible to assess, on the basis of the segregation ratios, not only the interaction of the non-allelomorphic genes that determine some morphological characters, but also many properties associated with these characters.

Wilkinson, R. C. 1974. REALIZED AND ESTIMATED EFFICIENCY OF EARLY SELECTION IN HYBRID POPLAR CLONAL TESTS. In Proceedings, 21st Northeastern Forest Tree Improvement Conference 26-33 [E., 4 ref.]
Genetic gain, as measured by the selection differential, increased with increase in age of selection, and selection for height at 1 or 4 years of age could exclude those clones that would be tallest at 15 years.

Winton, L. L. 1968. FERTILIZATION IN FORCED QUAKING ASPEN AND COTTONWOOD. Silvae Genet. 17 (1), (20-1). [9 refs. [E.e.].]
Describes experiments with Populus tremuloides and P. deltoides with the object of producing tetraploids, the first stage in the large-scale production of the more desirable triploid forms.

Wright, J. W. 1962.[1964.] GENETICS OF FOREST TREE IMPROVEMENT. FAO For. & For. Prod. Stud. No. 16, pp. xvi + 399 + 1 sheet of addenda. Many refs.

Zufa, L. 1964. [EARLY DIAGNOSIS IN THE IMPROVEMENT OF STEM FORM IN BLACK POPLARS.] In Proc. FAO World Consult. For. Genet., Stockholm 1963 No. 2a/11. pp. ii + 9. 30 refs. [F.f.e.span.]
From analysis of photographs of the stems of 2500 individuals of all ages from 8 natural strands, indices have been derived, whereby young trees may be reliably classified according to their probable mature stem form.

Zufa, L. 1968. THE PRESENT WORK ON POPLAR BREEDING IN ONTARIO. [Docum.] Int. Poplar Comm. 13th Sess. Montreal 1968 No. FO: CIP/13/39, pp. [iv] + 18. [18 refs. [E.e.f.].]
Briefly describes work on Aspens, involving multiple interspecific crosses, promising attempts at producing intersectional Leuce X Aigeiros X Tacamahaca hybrids, and selection and crossing of Populus deltoides.

Zufa, L. 1969. POLYPLOIDY INDUCTION IN POPLARS. Proc. 11th Mtg. Comm. For. Tree Breeding Can., Quebec 1968 Part 2, (169-74).
Induction of polyploidy was attempted in 5 Populus spp., with 16 different chemicals, using various treatments of vegetative tissues, reproductive organs, and seed.

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Giordano, E. 1974. MEETING IN ROMANIA OF THE INTERNATIONAL COMMISSION OF POPLAR. Cellul. Carta 25 (5):4-7 [It.]

IUFRO. 1966. [SELECTION AND BREEDING OF POPLARS, WILLOWS, AND ROBINA IN HUNGARY.] [Proc.] Mtg. Sect. 22 Int. Union For. Res. Organ., Hungary Vol. 1, (40-57, 113-5, 120-4). [E.]

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Muller, R. 1973/1974. KRITIK UND ENTFALSCHUNG EINER DISSERTATION. Dr. Wilfried Grosscurth uber Pappeln und die Sortenuntersuchung in Bruhl 1948-1962. Forstpflanzen-Forstsamen, Strassenhaus/Neuwied 13 (3) 89-96.

Muller, R. 1973. KRITIK UND ENTFALSCHUNG EINER DISSERTATION. Forstpflanzen-Forstsamen, Strassenhaus/Neuwied 13(1973), 4, 115-126 u. 131-138, 14(1974), 1, 5-14 u. 19-25, 14 (1974), 2, 43-48, [4 Lit. Ang.]

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Schonborn, A. von 1965. DIE ZUCHTERISCHE BEARBEITUNG DER PAPPELN IN DEUTSCHLAND. Holz-Zbl., Stuttg. 91 (108) 1879-1880, Lit. Verz.

Siwecki, R. 1969. INHERITANCE OF POPLAR ADAPTATION TO ASSOCIATIONS OF BARK MICROORGANISMS. Genet. Polon. 10 (3/4):134-137.

Zufa, L. 1969. POPLAR BREEDING IN CANADA. Forest Chron. 45 (6):402-408.

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Barna, M. M. 1970. CYTOEMBRYOLOGICAL FEATURES OF SEED FORMATION IN REMOTE HYBRIDIZATION OF POPULUS. Lesovod Agrolesomelior 23:86-95. [Ru.]

Quebec Minist. Lds. For. 1971. [POPLAR-GROWING IN QUEBEC. I. POPLAR BREEDING. II. DEVELOPMENT OF POPLAR-GROWING.] Rapport, Conseil de la Recherche et du Developpement Forestiers du Quebec No. 1. xi + 56 pp. [F., 7 ref.]

Stettler, R. F. 1968. IRRADIATED MENTOR POLLEN: ITS USE IN REMOTE HYBRIDIZATION OF BLACK COTTONWOOD. Nature, Lond. 219 (5155), (746-7). [16 refs. 1 tbl.]

Tyszkiewicz, S., and Chmielewski, W. 1968. HYBRIDIZATION OF POPLAR; HYBRYDYZACJA TOPOLI. Prace Instytutu Badawczego Lesnictwa 203:3-190.

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Kopecky, F. 1969. [THE IMPORTANCE OF POLYPLOIDS IN THE SELECTION OF FAST-GROWING TREE SPECIES.] Erdesz. Kutatas. 65 (1), (77-89). [Ru., 3 refs.]

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Dragavtsev, V.A. 1972. EXPERIMENTAL COMPARISON OF THREE PRINCIPLES IN THE ESTIMATION OF GENOTYPIC VARIABILITY OF QUANTITATIVE CHARACTERS IN PLANT POPULATIONS. Genetika 8 (5), (28-34). [Ru.e., 8 ref. From Plant Breeding Abstracts 43, 1503.]

Hattemer, H. H. 1969. [DIFFERENTATION OF POPLAR CLONES. I. THE VARIATION OF SINGLE CHARACTERISTICS.] Silvae Genet. 18 (5/6), (167-72). [G.e., 9 refs.]
In a nursery test, 101 clones representing Populus deltoides, P. euramericana, P. trichocarpa and intersectional hybrids between sections Aigeiros and Tacamahaca differed in each of 18 quantitative leaf traits. Characteristics related to shape and dimensions of the leaf base ranked highest in between-clone variation as estimated from nested univariate analyses of variance.

Steenackers, V. 1972. [1] THE STATE OF KNOWLEDGE IN BREEDING RUST RESISTANT POPLARS. [2] BREEDING POPLARS RESISTANT TO VARIOUS DISEASES. US Dep. Agric. Misc. Publ. No. 1221, (419-30, 599-607). [19 ref.]

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Anonymous. 1969. [DISEASE-RESISTANT POPLARS.] Tidsskrift for Planteavl, Kobenhavn 73 (426-8). [Dan. From abstr. in Plant Breed. Abstr. 40 (2), (No. 3842).]

Keremidciev, M. 1966. [RESISTANCE OF SOME POPLAR CLONES TO INSECT PESTS.] Gorskostop.Nauka, Sofija 3 (5), (401-11). 9 refs. [Bulg.ru.f.]

Kim, C. S., and Chung, S. B. 1974. [VARIATION IN THE PATTERNS OF ISOPEROXIDASE IN THE GENUS POPULUS I. VARIATION IN THE PATTERNS OF ISOPEROXIDASE IN P. ALBA, P. GLANDULOSA AND P. EURAMERICANA.] Research Report of the Institute of Forest Genetics, Korea No. 11. (53-59). [Kor.e., 11 ref.]
Zymograms were prepared from the leaves of 23 trees of P. alba (naturalized in Korea), 8 trees of P. glandulosa (native to Kyounggi province), ... IBN Korea.

Melchior, G. H., and Hattemar, H. H. 1967. DIE UNTERSCHEIDUNG VON PAPPELKLONEN MIT HILFE PHYSIOLOGISCHER MERKMALE. S.A.aus: "Forstpflanzen – Forstsamen", StraBenhaus, 2, 8 S. [5 Abb., 5 Tab., Lit. Verz.]

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Herpka, I. 1974/1975. [METHODOLOGY OF EARLY TESTING IN [TRIALS OF] POPLARS.] Topola 18/19 (103/106), (194-200). [Sh.e.ru.]

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Mathes, M. C. 1964. THE USE OF ISOLATED PLANT TISSUES IN STUDIES RELATED TO FOREST GENETICS. Tappi 47 (11), (710-3). 39 refs.
Recent advances in the culture of isolated plant tissues are discussed and their use in various investigations outlined.

17 SYSTEMATIC BOTANY

Broekhuizen, J. T. M. van 1971. [SYSTEMATICS AND TAXONOMY OF THE GENUS POPULUS.] Populier 8 (4), (74-77). [Du.]

172.8 EUMYCETES (TRUE FUNGI)

Commonw. Mycol. Inst. 1972. PATHOGEN: MELAMPSORA POPULNEA (PERS.) KARST. HOSTS: PINE (PINUS SPP.) AND POPLAR (POPULUS SPP.). Distribution Maps of Plant Diseases No. 389, Ed. 2. 2 pp. [E., many ref.]

Gojkovic, N. 1974. [RECENT INVESTIGATIONS ON THE MICROFLORA OF POPLARS AND WILLOWS IN YUGOSLAVIA.] TOPOLA 18 (102) 19-22 [Sh.f., 3 ref.]
Gives brief notes on a number of fungi observed on Poplars and Willows in Yugoslavia in 1972/73, some of the fungi being first records for the country.

Ondrej, M. 1972. [PARASITIC IMPERFECT FUNGI OF THE GENUS POLLACCIA ON POPULUS SPP.] European Journal of Forest Pathology 2 (3) 140-146 [De.e.f., 24 ref.]
A revision of the four species causing leaf-spot of Poplars, including descriptions of a new species, P. americana (on Populus grandidentata and P. tremuloides), and a new combination, P. ramulosa (on Populus alba). The remaining two species are P. radiosa (on Populus tremula) and P. elegans (on various species of Poplar).

Parmasto, E. [Editor.] 1965. [PROBLEMS IN STUDYING FUNGI AND LICHENS: IVTH SYMPOSIUM OF MYCOLOGISTS AND LICHENOLOGISTS OF THE BALTIC STATES: CONFERENCE ON METHODS OF STUDYING FUNGI AND LICHENS IN FOREST BIOCOENOSES.] Akademija Nauk Estonskoj SSR, Tartu. pp. 217. [Many refs. [Ru.e.g.f.] I.M.I.]

Sivanesan, A. 1974. VENTURIA MACULARIS. CMI Descriptions of Pathogenic Fungi and Bacteria No. 403, 2 pp. [E., 8 ref.]

Uozumi, T. 1967. [THE FINE SURFACE STRUCTURE OF UREDOSPORES OF THE POPLAR LEAF RUST, MELAMPSORA LARICIPOPULINA KLEB.] J. Jap. For. Soc. 49 (1), (29-30 + 2 plates). [8 refs.] [Jap.]
Illustrated by electron microphotographs.

176.1 DICOTYLEDONEAE

Anonymous. 1973. [POPLARS, POPULUS L.] Topole, Populus L. Warsaw, Poland, Panstwowe Wydawnictwo Naukowe. 516 pp. [Pol.e., many ref.]
This is No. 12 (but the third to appear) in a series of popular scientific monographs on the tree species of Poland.

Bernard, F. G. 1968. POPULUS X POLYGONIFOLIA HYBRIDA NOVA (SALICACEAE). NATURALISTE CANADIEN, QUEBEC 95 (3), (797-9). [F. N.L.L.]
Gives a line drawing of the foliage and a Latin diagnosis of this new putative hybrid, probably representing P. balsamifera x P. deltoides x P. tremuloides, based on a single young tree found near Montreal, Quebec.

Bogdanov, P. L. 1965. [POPLARS AND THEIR CULTIVATION.] Izdatel'stvo 'Lesnaja Promyslennost', Moscow. pp. 104. [38 refs. [Ru.] N.L.L.]
An account of research work at Leningrad over the last 30 years.

Borsdorf, W. 1964. [PROGRESS IN THE IDENTIFICATION OF POPLAR VARIETIES.] Zuchter 34 (6/7), (286-92). 14 refs. [G.g.] E.M.B.
Discusses fresh criteria for the identification of varieties, and critically examines some of those used by Muller and Sauer.

Borsdorf, W. 1965. [THE CLONE COMPLEX POPULUS X BEROLINENSIS AND RELATED VARIETIES.] Zuchter 35 (7), (327-35). 46 refs. [G.g.] E.M.B.

Broekhuizen, J. T. M. 1964. THE IDENTIFICATION OF POPLAR CLONES IN THE NURSERY. Transl. For. Comm., Lond. No. 209, pp. 13. Transl. from Ned. Bosb. Tijdschr. 36 (4), (105-18).

Broekhuizen, J. T. M. van. 1972. [MORPHOLOGICAL DESCRIPTION AND IDENTIFICATION OF A NUMBER OF NEW COMMERCIAL POPLAR CLONES.] Nederlands Bosbouw Tijdschrift 44 (7/8) 180-189 [Nl.e., 7 ref.]
Presents six short keys to help in distinguishing between the new clones and some of the older ones. The new name Populus X interamericana is proposed for the complex hybrid swarm between P. deltoides and P. trichocarpa, and a Latin diagnosis is given.

Bugala, W. 1967. [SYSTEMATY OF THE EURASIAN POPLARS OF THE POPULUS NIGRA GROUP.] Arboretum Kornickie, Poznan 12, (45-219). [201 refs. [Pol.e.ru.].]
A comprehensive monograph in four parts: (1) review of the literature on Black Poplars: (2) the taxonomic divisions of the genus Populus: (3) general characteristics of the Poplars of sect. Aigeiros; and (4) a detailed taxonomic study of the Eurasian Black Poplars.

Chardenon, J. 1967. [SOME IMPORTANT CULTIVATED POPLAR CLONES.] Bull. Serv. Cult. Etud. Peuplier et Saule, Paris (½), (43-57). [F.]
Discusses chiefly Populus nigra var. thevestina, describing two clones widely distributed in the drier parts of Turkey that are proposed for certification by the International Poplar Commission.

Chardenon, J. 1968. [THE PRINCIPAL CULTIVATED POPLAR CLONES.] Bull. Serv. Cult. Etud. Peuplier et Saule, Paris (1-22). [36 refs. [F.] 4 figs.]

FAO. 1969. INSTITUT DU PEUPLIER TURQUIE. VOL. 2 RAPPORT TECHNIQUE. [The Turkish Poplar Institute. Vol. 2. Technical report.] FAO, Rome. pp. ix + 655 + 3 figs. [F.]

Farmer, R. E., Jr., and McKnight, J. S. 1967. POPULUS: A BIBLIOGRAPHY OF WORLD LITERATURE, 1854-1963. U.S. For. Serv. Res. Pap. Sth. For. Exp. Sta. No. SO-27, pp. 132.
This partially annotated list was compiled from references supplied by The Commonwealth Forestry Bureau. It is arranged primarily by species or species-groups, the references to Poplars generally being grouped under Populus spp. The secondary breakdown is by the subject classification of the Oxford Decimal Classification for Forestry.

Frohlich, H. J. 1964. [IDENTIFYING CHARACTERISTICS OF POPLARS OF SECTION AIGEIROS.] Merkblatt, Forschungsinstitut fur Pappelwirtschaft, Hann. Munden No. 3. pp. 43 + one key card. [7 refs. [G.e.f.].]

Frohlich, H. J. 1964. [IDENTIFYING CHARACTERISTICS OF POPLARS OF SECTION LEUCE.] Merkblatt, Forschungsinstitut fur Pappelwirtschaft, Hann. Munden No. 2, pp. 47. [7 refs. [G.e.f.].]

Hattemer, H. H. 1965. [THE USE OF TWO RATIOS OF LEAF CHARACTERISTICS IN THE IDENTIFICATION OF HYBRID BLACK POPLAR CLONES.] Repr. from Zeitschrift fur Pflanzenzuchtung, Berlin 53 (4). (371-9). 5 refs. [G.g.e.]

Hattemer, H. H. 1966. [THE SUITABILITY OF SOME LEAF AND TWIG CHARACTERISTICS FOR DISTINGUISHING BLACK POPLAR HYBRID CLONES.] Zuchter 36 (7), (317-27). [14 refs. [G.g.e.] E.M.B.]
Characteristics (tree form, crown habit, and leaf characters) for the identification of 16 widely used clones are given in tabular form.

Javeid, G. N. 1972. SALICACCAE OF THE KASHMIR VALLEY. Indian Forester 98 (11):649-654 [E., 11 ref.]
Gives brief taxonomic descriptions of 21 exotic and indigenous species of Salix and Populus, with a key for their identification.

Koster, R. 1972. [ELEVEN NEW POPLAR CLONES, AN INTRODUCTION.] Nederlands Bosbouw Tijdschrift 44 (7/8), (173-179). schrift 44 (7/8), (173-179) [Du.e.]

Mottl, J., and Sterba, S. 1973. IDENTIFICATION OF POPLAR CLONES BY MEANS OF SEROLOGICAL REACTIONS. Communicationes Instituti Forestalis Cechosloveniae 8, 127-136 [E.ru., 46 ref.]
Compares the results obtained with three methods of serological testing of leaf extracts, and proposes a combined method (successive double electrophoresis applied crosswise in two agar layers) which yields markedly different precipitation lines and is recommended as a rapid and reliable method of clone identification.

Muller, R., and Sauer, E. 1968. ['OLD STOCK VARIETIES' OF BLACK POPLAR HYBRIDS FOR CULTIVATION IN GERMANY.] Bull. Serv. Cult. Etud. Peuplier et Saule, Paris (23-36). [11 refs. [F.].]

Muller, R., and Sauer, E. 1970. ['OLD STOCK VARIETIES' OF BLACK POPLAR HYBRIDS: THE 'ROBUSTA' POPLAR.] Bull. Serv. Cult. Etud. Peuplier et Saule (32-44). [F., 51 refs.]
A translation from the German of the account of this Poplar first published in Holz-Zbl. in 1960 81 (118), (1658:1663).

Ocskay, S., and Clonaru, A. 1969. [KEYS FOR IDENTIFYING POPLARS OF THE SECTION AIGEIROS GROWN IN RUMANIA.] Rev. Padurilor 84 (10), (499). [Rum.]

Papadopol, C. S. 1970. [STUDIES ON THE POSSIBILITY OF MORPHOMETRIC IDENTIFICATION OF POPLAR HYBRIDS.] Rev. Padurilor 85 (10), (610-5). [Rum., 11 refs.]

Petrov, M. 1965. [METHOD AND INDICES FOR DETERMINING LEAF SHAPE IN POPLARS OF SECTIONS AIGEIROS AND TACAMAHACA, AND THEIR HYBRIDS.] Gorskostop. Nauka, Sofija 2 (1), (61-73). [9 refs [Bulg.ru.e.].]
Describes a method whereby 14 different measurements are made on each leaf, and the ratios of 10 pairs of these measured values are used to define leaf shape.

Pourtet, J., Fanlo, F. J., Mayer-Wegelin, H., Meiden, H. A. van der. 1971. [REPORT OF THE INTERNATIONAL POPLAR COMMISSION SUB-COMMITTEE ON THE REGISTRATION OF POPLAR NAMES.] Topola 15 (88/89) 24-42 [Sh.]
Gives details of a scheme used for describing and registering Poplar cultivars (clones); it employs 85 different heads (i.e. characteristics), most of which are given a numerical rating on a points scale, usually from 1 to 5.

Pronin, D., and Vaughan, C. L. 1968. A LITERATURE SURVEY OF POPULUS SPECIES WITH EMPHASIS ON P. TREMULOIDES. U.S. For. Serv. Res. Note U.S. For. Prod. Lab., Madison No. FPL-0180 (rev.) pp. 67. [703 refs.]
An expanded version of the 1967 bibliography, including a large number of references to publications issued during 1966-67.

Roller, K. J., Thibault, D. H., Hildahl, V. 1972. GUIDE TO THE IDENTIFICATION OF POPLAR CULTIVARS ON THE PRAIRIES. Publication, Canadian Forestry Service No. 1311, 55 pp. [E.f., 9 ref.]
Gives an illustrated morphological guide to 3 native species and 13 cultivars, with a key based on leaf and twig characters.

Ronald, W. G., Lenz, L. M., and Cumming, W. A. 1973. BIOSYSTEMATICS OF THE GENUS POPULUS L. I. DISTRIBUTION

AND MORPHOLOGY OF NATIVE MANITOBA SPECIES AND VARIANTS. II. CHEMATAXONOMY, PHENOLOGY, FERTILITY, AND SEGREGATES OF NATIVE MANITOBA SPECIES AND VARIANTS. Candian Journal of Botany 51 (12):2431-2450 [E.f., 26 ref. ORS]

Sergeeva, V. N., Krejcberg, Z. N., and Ejtvide, M. Ja. 1969. [CHANGE IN THE FREE RADICALS IN POPLAR WOOD UNDER THE INFLUENCE OF GAMMA-RADIATION.] In Himija Drevesiny 3. Izdatel'stvo 'Zinatne', Riga. pp. 9-11. [12 refs. [Ru.ru.] 4 figs.]

Zycha, H., and Weisgerber, H. 1967. DIE ANFALLIGKEIT VON WEIBPAPPELARTEN UND-BASTARDEN GEGENUBER POLLACCIA RADIOSA. In: Ref. 24.IUFRO-Kongr., Munchen Bd. 3, S.852-860, 4 Abb.

18 PLANT ECOLOGY

181 MODE OF LIFE, AUTECOLOGY. SILVICULTURAL CHARACTER OF TREES

Anonymous. 1974. POPLARS IN THE PRAIRIE PROVINCES. Forestry Report, Northern Forest Research Centre, Canada 4 (1) 8 pp. [E., 9 ref.]

Baumeister, G. 1964. UNTERSUCHUNGEN ZUR FESTSTELLUNG DER RELATION ZWISCHEN AUFBLUHFOLGE UND ANSATZBEREITSCHAFT BEI BLUTEN VON POPULUS SEKTION LEUCE. Forst-u.Holzwirt, Hann. 19 (12): 271-272. [1 Abb.]

Garbaye, J. Tacon, F. Le [Le Tacon, F.] 1974. [THE BEHAVIOR OF VARIOUS PROVENANCES OF CONIFERS AND TWO CLONES OF POPLAR AS REGARDS THE pH AND CALCIUM CONTENT OF THE SOIL.] Revue Forestiere Francaise 26 (6) 439-446 [F.]

Guhathakurta, P. 1973. POPULUS GAMBLEI DODE—A LITTLE KNOWN POPLAR OF EASTERN HIMALAYAS. Forestry Conference; Dec. 1973, Dehradun.

Maini, J. S., and Cayford, J. H. [Editors]. 1968. GROWTH AND UTILIZATION OF POPLARS IN CANADA. Dep. Publ. For. Br. Can. No. 1205, pp. 257 + 8 maps. [Many refs.]

Meiden, H. A. van der. 1969/70. [CHARACTERISTICS AND POTENTIAL USES OF POPLAR SPECIES.] Populier, Wageningen 6 (3;4;5), (50-4; 58-62; 75-8); 7 (1), (4-10). [Du., 2 refs.]
Discusses the silvicultural characteristics, disease resistance, use for roadside plantings, spacings, properties and uses of the wood, etc., of a number of species and clones (illustrated by photographs).

Raschke, Gunther. 1974. WALDPAPPELN—BAUME MIT ZUKUNFT. RUCKBLICK UND AUSBLICK; FOREST POPLARS, TREES WITH A FUTURE. Holzzucht, Reinbek 28 (½) 11-18, [7 Abb., 25 Lit. Ang., dt. Zsfg.]

Safar, J. 1971. [POPLARS IN THE COASTAL REGION [OF JUGOSLAVIA]: SITES, AND ECOLOGICAL AND ECONOMIC IMPORTANCE.] Sum. List 95 (½), (1-12). [Sh.e., 6 ref.]
Gives a general account of the numbers and species of Poplars, their ecological characteristics.

181.1

Gerhard, H. 1965. DIE PAPPEL IN SCHLESWIG-HOLSTEIN. Forst-u.Holzwirt, Hann. 20 (12) 262-265, [6 Photogr.]

Kovacs, J. 1971. [THE POPLAR TREE HAS ITS PLACE OF ORIGIN IN THE SOUTH HANSAG ALDER FORESTS] Erdo 20 (9):385-388. Language [Hu.]

181.2

Barner, J. 1965. [EXPERIMENTS ON THE REACTION OF FOREST PLANTS TO LIGHT AND SHADE AS A FORM OF BASIC TESTING FOR USE IN CHOOSING SITES OR VARIETIES.] Mitt. Ver. Forstl. Standortskunde ForstpflZucht. No. 15, (65-9). [G.]

Lattike, H. 1965. [STUDY ON METHODS FOR EARLY DETERMINATION OF THE PHOTOTROPIC REACTIONS OF POPLAR AND WILLOW SPECIES.] Zuchter 35 (6), (267-78). 26 refs. [G.g.] E.M.B.
Preliminary field trials showed that pyramidal forms of Poplar (e.g. Populus nigra var. italica) are resistant to the effects of side lighting, whereas P. 'Marilandica' and some clones of P. trichocarpa are very sensitive.

Morita, K., and Sakai, A. 1966. [STUDIES ON FROST DAMAGE OF POPLARS. I. DIFFERENCE IN FROST HARDINESS AMONG VARIETIES OF HYBRID POPLARS.] J. Jap. For. Soc. 48 (7), (267-73). [12 refs. [Jap.jap.e].]
All varieties could withstand similar degrees of winter temperature after hardening, but length of growing season and rate of increase of frost hardiness (therefore the date on which maximum frost hardiness was reached) differed between varieties.

Paton, D. M., and Willing, R. R. 1968. BUD DORMANCY IN POPULUS. Aust. J. biol. Sci. 21 (1), (157-9). [6 refs. O.R.S.]
High temperatures (33/28°C. regime) inhibit the normal short-day control of the onset of dormancy, as indicated by cessation of stem elongation and formation of terminal buds, in certain Populus genotypes.

Pieters, G. A. 1972. MEASUREMENTS OF LEAF TEMPERATURE BY THERMOCOUPLES OR INFRARED THERMOMETRY IN CONNECTION WITH EXCHANGE PHENOMENA AND TEMPERATURE DISTRIBUTION. Wageningen Landbouwhogesch Mededel 72-34, 20 p. Ref.

Pryor, L. D. 1965. PHOTOPERIOD AND VERNALISATION IN POPLAR. Paper to the 4th Conference of the Inst. of Foresters of Aust. Hobart.

Sakai, A. 1964. [THE FROST-HARDENING PROCESS OF WOODY PLANT. X. THE EFFECTIVE FROST-HARDENING TEMPERATURE IN TWIG.] Low Temperature Science, Hokkaido (Ser. B.) No. 22, (29-49 + 10 photos). 24 refs. [Jap.jap.e.] E.M.B.

Sakai, A., and Horiuchi, T. 1972. [FREEZING RESISTANCE OF TREE TRUNKS.] Journal of the Japanese Forestry Society 54 (11) 379-382 [Jap.e., 12 ref.]
Two conifers native to Hokkaido (Abies sachalinensis and Picea glehnin) and two Poplars (Populus 'I-455' and P. 'Geltica') were the most resistant to freezing; they withstood -60 without injury even to the xylem.

Wagenbreth, D. 1965. [CHANGES IN VITALITY INDUCED IN LEAVES OF HARDWOODS BY HEAT SHOCK.] Flora, Jena 156A (1), (63-75). 15 refs. [G.g.e.] O.B.D.
When halves of leaves were heat-treated, the treated halves had a reduced but more constant respiration rate and lived longer than the untreated halves. This was due to heat hardening of the tissue during the process of heat shock.

Yoshida, S. 1973. [THE INTRACELLULAR LOCALIZATION OF PHOSPHOLIPIDS AND THEIR BEHAVIOUR UPON HARDENING AND DEHARDENING IN THE CORTICAL TISSUES OF WOODY PLANTS.] Low Temperature Science, B 31, 21-30 [Jap.e., 15 ref. BLL]
The results suggest that some qualitative change in the cell membranes is involved in the hardening process.

Zhiboedov, P. M. 1973. [WATER-RETAINING CAPACITY OF SHOOTS, ONE OF THE DIAGNOSTIC INDICES OF WINTER-HARDINESS IN POPLARS.] Nauch. tr. Kazakhsk. NII les. kh-va No. 8:163-172 [Ru., 24 refs.] From Referativnyi Zhurnal (1974) 5.56.144. Ru. NLL.
The water-retaining capacity of the leaves was not useful for predicintg winter-hardiness, but that of the shoots was related to the winter-hardiness of the Poplars, and on this basis some 16 different Poplar species and clones are classified into four groups as regards winter-hardiness in Kazakhstan.

Ziboedov, P. M., and Fescenko, N. I. 1968. [FEATURES OF THE ANNUAL CYCLE OF GROWTH AND DEVELOPMENT OF POPLARS IN CONNEXION WITH THEIR WINTER-HARDINESS.] Bjull. Glavn. Bot. Sada, Moskva No. 71, 102-7) [15 refs. [Ru.] N.L.L.]

No close correlation was observed between winter-hardiness and the duration of growth, its start, or its end.

181.21

Werner, H., and Dagenback, H. 1965. ERFAHRUNGEN MIT DER ROCHESTER-PAPPEL IN SCHATTIGEN BACHTALCHEN. Mitt. Ver. Forstl. Standortskde.Forst-pflZucht Stuttg. 15, p. 56-64, 11 Abb., 5 Tab., 5 Lit. [Ang. engl. Zsfg.]

181.3

Adorjan, J. 1968. [SITE AND YIELD STUDIES ON POPULUS 'ROBUSTA' AND P. 'I-214' ON HIGH-GROUND-WATER SITES OF THE SOMOGY SAND REGION.] Erdesz. Kutatas., Budapest 64 (1/3), (77-82). [Hu.ru.g.]

Anonymous. 1971. BIBLIOGRAPHY ON SOIL RELATIONSHIPS, NUTRITION AND FERTILIZING OF POPLAR (POPULUS SPP.) (1970-1956). Bibliogr. Bur. Soils No. 1454, pp. 24. [103-ref.]

Babos, I. 1964. [SITE STUDIES ON POPULUS 'ROBUSTA' IN THE [HUNGARIAN] FOREST GROWTH REGIONS WITH SANDY SOILS.] Erdesz. Kutatas., Budapest 60 (1/3), (49-85). 12 refs. [Hu.ru.g]
The cultivation of Populus 'Robusta' on forest sites is discussed, and the results are given of a study of litter, water use, root systems (illustrated), timber quality and growth in 424 stands in the sand region of Hungary.

Chirita, C. D., and Nicolau, M. 1968. [STUDIES ON THE MOISTURE AND NUTRIENT STATUS OF THE SOIL IN RELATION TO THE VEGETATIVE GROWTH OF EURAMERICAN POPLARS.] Rev. Padurilor 83 (9), (460-8 + smries.) [12 refs. [Rum.f.e.g.ru.].]

Iakushev, B. I. 1971. DETERMINATION OF INTENSITY OF TRANSPIRATION BY ELECTROCHEMICAL HYGROMETER. Akad. Nauk. Belorussk Ssr Dokl. 15 (1):74-77, [Ru.]

181.31

Dekanic, I. 1966. [THE INFLUENCE OF GROUND WATER ON THE GROWTH OF POPULUS X MARILANDICA IN FORESTS AND IN INTENSIVELY CULTIVATED PLANTATIONS IN THE ALLUVIAL PLAINS OF THE DANUBE AND THE DRAVA NEAR OSIJEK.] Topola, Beograd 10 (59/60), (5-28). [2 refs. [Serb.f.f.].]

Dekanic, I. 1967. [THE EFFECT OF GROUND-WATER LEVEL ON THE GROWTH OF HYBRID BLACK POPLARS.] Schweiz. Z. Forstw. 118 (11), (724-36). [5 refs. [G.f.].]
[Cf. F.A. 28 No. 5237.] At age 9, Populus 'Serotina' planted on alluvial soil, in the Sava basin in Jugoslavia, had grown better on a plot with a mean water table of 195 cm. in the growing season than on adjoining plots with water tables at 243 and 165 cm. respectively.

Dekanic, I. 1967. [THE INFLUENCE OF GROUND-WATER ON THE GROWTH OF POPULUS 'SEROTINA' GROWN IN PLANTATIONS IN THE SPACVA REGION.] Topola, Beograd 11 (61/64), (64-94). [4 refs. [Serb.serb.f.].]

Ganchev, P. 1967. [STUDIES ON THE TRANSPIRATION RATE AND WATER-RETAINING CAPACITY OF LEAVES IN INTERSPECIFIC POPLAR HYBRIDS AND THEIR PARENT SPECIES.] Gorskostop. Nauka, Sofija 4 (1), (59-68). [11 refs. [Bulg.ru.e.].]
Black Poplars had a greater water-retaining capacity than Balsam Poplars, and some hybrids possessed greater water-retaining capacity than their parents.

Ganchev, P. 1972. [STUDIES ON THE WATER REGIME OF SOME INTERSPECIFIC POPLAR HYBRIDS.] Gorskostopanska Nauka 9 (4):31-36 [Bulg.ru.e. 4 ref.]
Tabulates data on the leaf moisture content and % of free and bound water, length of veins per unit leaf area, etc. for a number of plants of two hybrids (Populus nigra var. thevestina X P. simonii and P. alba X P. tremula), and for the parent species.

Ganchev, P. and Iovov, D. 1972. [GROWTH AND DEVELOPMENT OF SOME POPLARS IN RELATION TO SOIL MOISTURE.] Gorsko Stopanstvo 28 (8) 31-35 [Bulg., 1 ref.]

Harris, S. A. 1974. ANNUAL SOIL MOISTURE REGIMES IN THE ROOTING ZONE ACROSS THE PRAIRIE-FOREST BOUNDARY OF SOUTH-WEST ALBERTA. Journal of Soil Science 25 (4):448-460. [E., 14 ref.]

Lebedev, V. V., and Egorenkov, A. P. 1972. [THE HYDROLOGICAL SIGNIFICANCE OF SHELTERBELTS ON IRRIGATED LAND IN THE VOLGA REGION.] Lesnoe Khozyaistvo No. 5. 38-42 [Ru.]

Manolova, I., and Palashev, I. 1974. [THE WATER-RETAINING CAPACITY OF THE ROOTS OF SOME FOREST TREE SPECIES.] Gorskostopanska Nauka 11 (2):14-19 [Bulg.ru.e., 1 ref.]
Data are given on the moisture content of skeleton roots of 10 broadleaved and 5 coniferous tree species in Bulgaria. M.c. was greater than 120% in all the conifers and also in Lime and Poplar; it was less than 100% in the other eight broadleaves species.

Mraz, K., and Sika, A. 1966. [SOIL AND ROOT STUDIES AS A BASIS FOR RAISING POPLARS ON BROWN EARTHS AND BROWN ALLUVIAL SOILS.] Lesn. Cas. Praha 12 (12), (1069-84). [8 refs. [Cz.ru.e.g.].]
[Cf.F.A. 24 No. 242.] Data so far obtained from comparative studies in Populus X marilandica plantations established in 1958 and 1962 on loamy brown earth (low ground-water level) and brown alluvial soil (high ground-water level) have confirmed that good results can be achieved on soils without readily accessible ground water near the surface.

Naidenova-Yaneva, Ts. 1974. [COMPARATIVE STUDIES ON THE EFFECT OF SOIL MOISTURE ON THE GROWTH AND TRANSPIRATION OF SOME FORMS OF POPLAR.] Gorskostopanska Nauka 11 (5):42-52 [Bulg.ru.e., 9 ref.]
Four clones (Populus 'I-214', 'I-262', 'I-455', and 'Weltheimeipappel') were grown in pots of alluvial soil or brown forest soil, with the soil m.c. maintained at 100, 85, 70, 55, 40, and 25% of maximum water-holding capacity. The amounts of water transpired per plant and per g of increment were determined. In all clones, maximum increment was obtained with soil m.c. 70-85%.

Schmidt, P. 1973. [WATER CONSUMPTION OF DIFFERENT POPLAR CLONES.] Allgemeine Forst- und Jagdzeitung 144 (3):63-64 [De.e.f., 3 ref.]

Stefanov, B., and Najdenova, C. 1967. [EFFECT OF SOIL MOISTURE ON THE TRANSPIRATION AND INCREMENT OF VEGETABLE MATTER IN SOME SPECIES OF POPLAR.] Gorskostop.Nauka, Sofija 4 (2):(3-15). [4 refs. [Bulg.ru.g.] 7 tbls.]

181.32/.34

Bucur, N., et al. 1967. [TOLERANCE OF SALINITY BY SOME WOODY SPECIES GROWN IN SALINE SOILS IN THE JIJIA-BAHLUI DEPRESSION.] Lucrari Stiintifice, Institutul Agronomic 'Ion Ionescu de la Brad', Iasi (119-23). [3 refs. [Rum.ru.f.] C.G.B.]
Reports the results of tests to determine the tolerance to SO_4, Cl, and total soluble salts, of a number of species for planting in very saline soils. The four recommended are Elacagnus angustifolia, Acer negundo, Populus X euroamericana, and Aesculus hippocastanum.

Burg, J. van den, Guildemond, J. L., and Peeters, J. P. 1973. [MINERAL NUTRITION OF BROADLEAVED TREES ON DUMP SOILS AND OTHER SITES UNKNOWN IN FORESTRY.] Nederlands Bosbouw Tijdschrift 45 (7/8) 221-230 [NLe., 18 ref.]
Gives an account of investigations on the nutrient status of various broadleaved species planted on 22 different 'unnatural' sites in urban areas in Holland, viz. peat soils: dumps of sand, clay, peat or mixed soils; and refuse dumps.

Catrina, I., Huluta, C., Constantinescu, V., Dobrescu, Z., and Popa, A. 1973. [RADIOISOTOPE STUDIES ON THE MINERAL NUTRITION OF HYBRID BLACK POPLARS.] Studii si Cercetari, Institutul de Cercetare, Proiectare si Documentare Silvica, I. (Silvicultura) 29, 113-140 [Rom.e.f., 21 ref.]

Chirkova, T. V. 1973. [ROLE OF ANAEROBIC RESPIRATION IN THE ADAPTION OF SOME WOODY PLANTS TO TEMPORARY ANAEROBIOSIS.] Vestnik Leningradskogo Universiteta No. 3 (Ser.Biol. No. 1), 88-95, [Rum.e. ,19 ref. ORS]

Dykstra, G. F. 1973. CRITICAL NITROGEN LEVEL OF TWO POPULUS CLONES: GROWTH, NITRATE REDUCTASE AND ALLOMETRIC RESPONSE. [Abstract]. Dissertation Abstracts International. B. 33 (8) 3411-3412, [E., ORS, Order No. 74-3877]
There were marked differences between the clones (both of which had been selected for rapid growth) for nitrate-reductase response, N% and protein content, indicating considerable genetic variations between them.

Ivers, F. H. 1964. [THE IMPORTANCE OF FORM OF N FOR GROWTH AND NUTRITION OF FOREST TREES.] Mitt. Ver. Forstl. Standortskunde ForstpflZucht. No. 14, (19-37). 81 refs. G.g.e.]
In both Spruce and Poplar, Ca deficiency reduced growth considerably in the NH_4, but only slightly in the NO_3 series.

Fritzsche, K. 1970. [THE EFFECT OF NUTRITION ON THE SIZE OF POPLAR LEAVES.] Tagungsbericht, Deutsche Akademie der Landwirtschaftswissenschaften zu Berlin No. 103, (13-23). De.ru.e., 15 ref.]
Describes pot trials with the Black Poplar hybrid P. 'Forndorf' and the Balsam Poplar hybrid P. 'Androscoggin' and studies in plantations (mostly 9 years old) of these cultivars and Populus trichocarpa.

Giulimondi, G. 1966. [MINERAL CONTENTS OF HYBRID BLACK POPLARS.] Pubbl. Cent. Sper. Agric. For., Roma 193-214). [20 refs. [It.it.e.e.].]
Mineral content of the whole tree (based on dry weight) varied considerably, variability being in the order P>K>N>Ca (fairly uniform).

Lemoine, M. 1969. [COMPARATIVE GROWTH OF POPLARS OF THE SECTIONS LEUCE AND AIGEIROS ON PSEUDO-GLEY SOIL.] [Pap.] 2nd FAO/IUFRO World Consult. For. Tree Breed., Washington 1969 No. FO-FTB-69-2/14, pp. [8]. [F.f.e.]

Liani, A. 1972. [FURTHER RESEARCH ON THE CATION EXCHANGE CAPACITY OF POPLAR ROOTS.] Pubblicazioni del Centro di Sperimentazione Agricola e Forestale 11 (3) 193-204 It.e., 26 ref.]
The active hydrogen on root surfaces, and the cation exchange capacity (c.e.c.) of roots, were determined on Populus '62/55', UAS 235', '49/51' and 'I-214' grown in pots in sand, N-fertilized and or compost-fertilized sand, or grown in sandy soil in the field.

Ljameborsaj, S. H. 1968. [CALCULATION OF THE COEFFICIENTS OF REMOVAL OF N AND ASH ELEMENTS BY DIFFERENT TREE SPECIES.] Doklady, Moskovskaja Sel kohozjajstvennaja Akademija im. K. A. Timivjazeva, Moskva (13), 411-5). [Ru.] From abstr. in Referat. Z., Moskva (9.56.59). [Ru.] J.L.L.]

Mraz, K. 1965. [RELATIONSHIP BETWEEN THE VARIATION IN THE NITRATE CONTENT OF SOILS THROUGHOUT THE YEAR AND THE GROWTH OF POPLARS.] Lesn. Cas., Praha 11 (1), (17-34). [15 refs. [Cz.cz.ru.f.g.].]
Results showed a close relationship between nitrate content and other soil properties, particularly the water and air regimes, and its importance for fast-growing species such as Poplars.

Mraz, K., and Lochman, V. 1965. INFLUENCE OF ECOLOGICAL CONDITIONS ON SAND AND CLAY SOIL UPON GROWTH OF YOUNG EURAMERICAN POPLARS. Commun. Inst. For. Csl. 4, 187-203). 6 refs. [E.e.ru.]
Gives preliminary results of studies comparing the growth of 1-year plants of nine cultivars of p. X euramericana on formerly cultivated sites.

Phares, R. E. 1965. GROWTH AND NUTRITION OF HARDWOOD SEEDLINGS ON SOME CENTRAL STATES FOREST AND OLD-FIELD SOILS. Abstr. in Proc. Soc. Amer. For. 1964. (46-7)
Green Ash and Cottonwood responded more to fertilization than did Red Oak and Black Walnut, probably owing to their having smaller seed with less self-contained nutrient material and a greater natural capacity for absorbing P.

Prpic, B., and Filipan, T. 1971. [DISTRIBUTION OF P^{32} IN SOME CONIFERS IN POPULUS 'ROBUSTA'.] Topola 15 (83/85), 79-87). [Sh.de., 10 ref.]
Describes experiments on four conifer species and P. 'Robusta' in which P^{32} was applied to (1) the foliage, (2) the conducting elements of the stem, and (3) the soil.

Sumakov, V. S. 1964. [EFFECT OF POPLAR ON THE FOREST-GROWTH PROPERTIES OF THE SOIL.] Sborn. Rabot Lesn. Hoz. Vsesojuz. Nauc.-Issled. Inst. Lesovod. No. 49, (132-52). [Ru.]
The Poplars increased the general biochemical activity of the alluvial soil, but almost completely depressed its nitrifying capacity.

Viart, M. 1965. [POT TRIALS ON THE GROWTH POPLARS.] Bull. Serv. Cult. Etud. Peuplier et Saule, Paris (1), (14-36) + 3 gphs). 3 refs. [F.]

Yadav, J. S. P. and Prakash, Jai. 1968. SOIL CONDITIONS GROWING POPLAR PLANTATIONS IN TARAI AREA OF UTTAR PRADESH. Proc. Symposium Forest & Forest Based Industries Dehradun.

Yadav, J. S. P., and Prakash, J. 1971. SOIL CONDITIONS [FOR] GROWING POPLAR PLANTATIONS IN TARAI AREA OF UTTAR PRADESH. Van Vigyan 9 (3/4) 72-83 [E., 7 ref.]

Zeltikova, T. A. 1967. [THE AMELIORATION CAUSED BY FOREST STANDS ON ALLUVIAL-CONE PEBBLE-BEDS IN [SOVIET] CENTRAL ASIA.] Lesoved., Moskva (4),(36-46). [12 refs. [Ru.e.].]
After one rotation (15-20 years under stands of e.g. Populus spp.) soil development is sufficiently advanced for both agricultural crops and more valuable tree species to be planted.

181.34

Anonymous. 1965. WACHSTUM AND NAHRSTOFFAUFNAHME VERSCHIEDENER SCHWARZPAPPELKLONE. Allg.Forstz., Munchen 20, 16/17, S.253.

181.341

Fritzsche, K. H., Jungnickel, H., and Fielder, H.-J. 1968. [ON THE POSSIBILITY OF USING THE MITSCHERLICH FUNCTION IN POT TRIALS WITH POPLAR.] Arch.Forstw. 77 (8), (857-71). [8 refs. [G.g.ru.e.] 9 figs. 2 tbls.]

181.342

Miloserdov, N. M. 1969. POPLARS IN SHELTERBELTS ON CHESTNUT-SALINE SOILS. Transl. Dep. For. Can. No. 303, pp. 3. [Transl. from Lesn. Hoz. 1960 (2), (41). [Ru.]
Quotes examples of the satisfactory growth of the 'Canadian' and the 'Turkestan' Poplar on these soils in the southern Ukraine, in support of proposals for their wider use in shelterbelts and windbreaks.

181.35

Bartoli, A., and Rambelli, A. 1973. [MYCORRHIZAL SYMBIOSIS IN A POPLAR STAND IN CENTRAL ITALY.] Pubblicazioni del Centro di Sperimentazione Agricola e Forestale 12, 37-41 + 1 pl. [It.e., 5 ref.]

Fontana, A., and Centrella, E. 1967. [ECTOMYCORRHIZAE PRODUCED BY HYPOGEOUS FUNGI [IN PIEDMONT].] Allionia, Torino 13, (149-76). [48 refs. [It.e.] O.B.D.]

Fontana, A., and Palenzona, M. 1969. [MYCORRHIZAL ASSOCIATION OF TUBER ALBIDUM [GROWN] IN PURE CULTURE WITH PINUS STROBUS AND POPULUS x 'CANADENSIS'.] Repr. from Allionia 15, (99-104). [It.e., 10 refs.]
Describes the culture in vitro, for the first time, of large quantities of T. albidum mycelium, and the successful inoculation of Pinus strobus and Populus x 'canadensis', mycorrhizae being formed on both species.

Meistrik, V. 1971. [ANATOMICAL AND MORPHOLOGICAL STUDY OF MYCORRHIZAE FOR THE PURPOSES OF AFFORESTATION.] Sbornik Vedeckcho Lesnickeho Ustavn Vyslke Skoly Zemedekske v Praze (1969) No. 12, 221-249 + 4 tab. [Cs.ru.e., 27 ref.]
[Cf. FA 31, 376, 2184] Compares in detail the mycorrhizal 'spectra' of Alnus glutinosa, Betula verrucosa, Fraxinus excelsior, Populus x euramericana, Quercus rubra, Sambucus racemosa and Tilia tomentosa growing on colliery tips in Czechoslovakia.

Mosca, A. M. L. 1973. [THE MYCOFLORA OF THE RHIZOSPHERE IN TRUFFLE SOILS. IV. MICROFUNGI IN THE ROOT REGION OF SOME POPLARS GROWING IN MYCORRHIZAL ASSOCIATION WITH TUBER MAGNATUM.] Allionia 19, 29-32 [It.e., 6 ref. BLL]
Describes qualitative studies on the microfungi present in the root region of Populus x euramericana [P. x canadensis] hybrids growing in a 15-year-old plantation in Piedmont in mycorrhizal association with the truffle fungus T. magnatum.

Vozzo, J. A., and Hacskaylo, E. 1974. ENDO- AND ECTOMYCORRHIZAL ASSOCIATIONS IN FIVE POPULUS SPECIES. Bulletin of the Torrey Botanical Club 101 (4): 182-186 [E., 6 ref. OBD]
After inoculation with mycorrhizal fungi in soil, potted seedlings of P. fremontii, P. grandidentata and P. tremuloides formed ectomycorrhizal roots, P. heterophylla formed no mycorrhizae, and P. deltoides and P. deltoides var. occidentalis formed both ecto- and endomycorrhizae.

181.36

Bartkowiak, S., and Bialobok, S. 1965. [INVESTIGATION OF THE RELATION BETWEEN VOLUME OF THE ROOT SYSTEM AND THE HEIGHT OF POPLAR HYBRIDS.] Arboretum Kornickie, Poznan 10, (169-73). 3 refs. [Pol.e.ru.]
The correlation coefficient was quite high in the first year, but there was no correlation between 1-year seedling root volume and stem height (or diameter) at 6 years. Accordingly, root volume of the 1-year seedling is of no value as an early test in Poplar selection.

Bondarenko, N. I. 1967. [ROOT SYSTEM DEVELOPMENT IN POPULUS NIGRA VAR. ITALICA AND P. x BEROLINENSIS IN RELATION TO METHOD OF PROPAGATION.] In Kornevaja sistema i produktivnost sel'skohozjajstvennyh rastenij. Izdatel'stvo 'Urozaj', Kiev. pp. 151-7. [Ru. E.M.B.]
P.n. var italica formed in a stronger root system than P. x berolinensis. In P.n. var. italica both types of plant formed strong root systems, but the seedlings were superior to the rooted cuttings.

Frohlich, H. J., and Dietze, W. 1970. [INVESTIGATIONS INTO THE ROOT DEVELOPMENT OF PLANTS OF POPULUS SECTIONS AIGEIROS, LEUCE AND TACAMAHACA.] Silvae Genet. 19 (4), (131-42). [G.e., 18 refs.]
The relations between rooting and leaf development in Populus spp. of these three sections were studied in the laboratory on different soil media and in the field. Planting recommendations are made.

Frohlich, H. J., and Dietze, W. 1971. ROOT DEVELOPMENT IN AIGEIROS, LEUCE, AND TACAMAHACA POPULUS. Holzzucht 25 (1): 1-4. [G.]

Harabin, Z. 1971. [EFFECT OF THE TOXIC PROPERTIES OF SPOIL-MOUND MATERIAL ON THE DEVELOPMENT OF THE ROOT SYSTEMS OF TREES.] Sylwan 105 (2), (51-65). [Pol.ru.e., 10 refs.]

Joachim, F. F. 1974. ROOT FORMATION AND THE SHOOT/ROOT RATIO OF POPLARS. In Int. Symp. Ecol. and Physiol. of Root Growth 2d: 133-138. Ref. [G.]

Kitin, B. 1970. [DEVELOPMENT OF THE ROOT SYSTEM IN SOME FORMS OF POPLAR.] Nauch. Trud. Lesotekh. Inst. (Ser. Gorsko Stop.) No. 18, (83-91). [Bg.ru.fr., 9 ref.]

Kitin, B. 1972. [ROOTING INTENSITY IN SOME POPLAR VARIETIES.] Gorskostopanska Nauka 9 (4), (37-46). [Bg.ru.f., 8 ref.]

Najdenova-Janeva, C. 1966. [EFFECT OF CERTAIN FACTORS ON THE GROWTH OF THE ROOT SYSTEM IN POPULUS x REGENERATA.] Gorskostop. Nauka, Sofija 3 (2), (113-22). [8 refs. [Bulg.ru.e.].]
Root growth was greater on plots where stumps had been cleared and the ground completely ploughed, and where plant spacing was widest. It was best when water melons were used as the agricultural intercrop, and worst with beans, maize being intermediate. NPK as a basic fertilizer improved root growth, but top-dressing with N had a harmful effect.

Nikitin, I. A. 1974. [SOME TYPES AND FEATURES OF THE STRUCTURE OF THE ROOT SYSTEMS OF POPLARS.] Nauch. tr. Ukr. s.-kh. akad. No. 93, 17-26 [Ru.] From Referativnyi Zhurnal (1975) 3.56.89. Ru. BLL.
Studies of Poplars in the Ukraine and south-central Russia showed that the root systems were extremely plastic, and that their structure and development were determined by the site conditions, species mixture, method of plantation establishment, and the planting stock used.

Sika, A., and Mraz, K. 1964. [THE IMPORTANCE OF ROOT PENETRATION IN FLOODPLAIN-FOREST SOILS WITH SPECIAL REFERENCE TO THE CULTIVATION OF FAST-GROWING TREE SPECIES.] Prace Vyzkum. Ust. Lesn. CSSR No. 28, (81-137). 46 refs. [Cz.ru.g.]

181.4

Kolesnichenko, M. V., and Chumakov, V. V. 1973. [BASIS FOR SELECTION OF SPECIES FOR ADMIXTURE IN MIXED PLANTATIONS OF CANADIAN POPLAR.] Lesnoi Zhurnal 16 (5) 12-16 [Ru., 9 ref.]

Red'ko, H. I. 1973. INFLUENCE OF SUNDIAL LUPINE ON GROWTH OF POPULUS. Visn Sil's'kohspod Nauki 6: 84-87. [Ukr.]

181.41

Guldemond, J. L. 1966. [THE EFFECT OF DENSE WEED COVER ON POPLAR GROWTH.] Populier, Wageningen 3 (4): 62-3. [Du.du.] [3 photos. 2 tbls.]

181.6

Domanski, R. 1969. [RELATIONSHIP BETWEEN SHOOT GROWTH OF POPLARS IN A NURSERY AND TEMPERATURE AND PRECIPITATION IN 1962 AND 1963.] Sylwan 113 (11), (37-42). [Pol.ru.e., 8 refs.]

Domanski, R. 1974. [SEASONAL CHANGES IN THE INCREMENT OF SHOOTS OF SEVERAL POPLAR VARIETIES IN A NURSERY IN 1969-70.] Sylwan 118 (9): 50-62 [Pl.ru.e., 11 ref.]

Ganchev, A., and Delkov, N. 1973. [DYNAMICS OF BRANCHING IN SOME POPLARS.] Nauchni Trudove, Vissh Lesotekhnicheski Institut, Sofiya (Gorsko Stopanstvo) 19, 67-71 [Bg.ru.de., 4 ref.]
In studies in Bulgaria, assessments were made of the incidence of branching on the current annual extension shoots of one-year plants (from rooted cuttings) and stools, and on the current annual extension shoots of older plants of 133 clones in Poplars.

Lieth, H., Osswald, D., and Martens, H. 1965. [DRY-MATTER PRODUCTION, SHOOT/ROOT RATIOS, CHLOROPHYLL CONTENT AND FOLIAGE AREA OF YOUNG POPLARS.] Mitt. Ver. Forstl. Standortskunde ForstpflZucht. No. 15, (70-4). 12 refs. [G.g.e.]
A study chiefly on Populus 'Oxford' aged 1-8 years. Dry-weight production (leaves, stem, branches and roots) and shoot/root ratios increased with age, except that the shoot/root ratio declined sharply during the first growing season.

Smirnov, V. V., and Semenova, V. G. 1973. PRODUCTIVITY OF OVERGROUND PARTS OF 28-YEAR-OLD POPULUS STAND IN THE SOUTHERN FOREST-STEPPE SUBZONE. Produktivnost' Organicheskoi Massy Lesov v Raznykh Priorodnykh Zonakh p. 70-80. Ref. [Ru.]

Witkowska-Zuk, L. 1972. [GROWTH AND FORM OF THE CROWN OF POPULUS x BEROLINENSIS. (I) STRUCTURE AND GROWTH POTENTIAL OF BUDS.] Rocznik Sekeji Dendrologicznej Polskiego Towarzystwa Botanicznego 26, 95-106 [Pl.e., 18 ref.]
Crown regeneration was inversely proportional to the amount of crown reduction. Shoot growth did not depend on bud structure, and nearly all the buds (except very small dormant buds) were able to participate in crown regeneration.

Witkowska-Zuk, L. 1973. [GROWTH AND FORM OF THE CROWN OF POPULUS x BEROLINENSIS. (II) EFFECT OF REDUCTION OF THE CROWN.] Rocznik Sekcji Dendrologicznej Polskiego Towarzystwa Botanicznego 27, 139-153 [Pl.e., 16 ref.]

Zukova, V. M. 1969. [THE AERIAL PHYTOMASS OF ASPEN IN FOREST COMMUNITIES OF THE MOSCOW REGION.] Lesoved., Moskva (3), (39-46). [8 refs. [Ru.e.].]
A detailed study was made of sample trees from stands aged 25, 35, 55 and 75 years.

181.65

Bate, G. C., and Canvin, D. T. 1972. SIMULATION OF THE DAILY GROWTH OF AN ASPEN POPULATION FROM THE MEASURED CO_2-EXCHANGE RATES OF THE COMPONENTS. Canad. J. Bot. 50 (1): 205-14. [16 ref. ORS]

Schlenker, G. 1964. BEOBACHTUNGEN UBER DAS JUGENDWACHSTUM EINIGER PAPPELSORTEN AUF VERSCHIEDENEN STANDORTEN IN NORDWURTTEMBERG. Forst- u. Holzwirt, Hann. 19, 12, 262-266. [5 Abb., 2 Tab., Lit. Ang.]

Schmitz-Lenders, R. B. 1970. BEDEUTUNG DES WARMEFAKTORS FUR DEN PAPPELZUWACHS. Forst-Holzwirt, Hann. 25: 17, [S.379, 2 graph. Darst.]

181.8

Fakirov, V. 1973. [PHENOLOGICAL CHARACTERISTICS OF SOME POPLARS IN THE DANUBE REGION [OF BULGARIA].] Gorskostopanska Nauka 10 (5): 3-19 [Bg.ru.de., 27 ref.]
Tabulates data on the phenology of 38 Poplar clones, from studies on drained sites near the Danube in 1960-66.

Melchior, G. H., and Hattemer, H. H. 1966. [THE IDENTIFICATION OF BLACK POPLAR CLONES BY THEIR PHYSIOLOGICAL CHARACTERISTICS.] Silvae Genet. 15 (4): 111-20. [40 refs. [G.g.e.].]

Morgeneyer, W., and Borsdorf, W. 1965. [PHENOLOGICAL STUDIES IN THE POPLAR COLLECTION AT GRAUPA.] Arch. Forstw. 14 (4): 369-86 + 1 tbl. 34 refs. [G.g.ru.e.]
Varieties and hybrids of the section Tacamahaca tended to be early flushers and to have long growing seasons (the longest was that of Populus 'Rochester'), through there were exceptions. The stage of 'green tips showing' proved the most suitable for comparisons.

Red'ko, G. I., and Red'ko, G. F. 1964. [THE COURSE OF HEIGHT INCREMENT IN POPLARS DURING THE GROWING SEASON.] Ukr. bot. Z. 21 (6), (25-31). 4 refs. [Ukr.ru.e.] A.P.B.
Tabulates monthly data on the height growth of 15 different species and hybrids in 1961 in the Zhitomir region of the Ukraine.

Vibe, G. G. 1967. [VARIABILITY OF INCREMENT IN POPLARS AS A FUNCTION OF ECOLOGICAL FACTORS ON THE SALINIZED SOILS OF THE TRANS-URALS FOREST-STEPPE REGION.] Lesn. Z., Arhangel'sk 10 (6), (32-4). [4 refs. [Ru.].]
Results showed that air temperature was more important than relative humidity or soil temperature and moisture.

182 SYNECOLOGY, PLANT SOCIOLOGY

Demidenko, V. P. 1970. VERTICAL STRUCTURE OF THE ABOVE GROUND PLANT COMMUNITY OF YOUNG ASPEN TREES OF THE SOUTH TAIGA SUBZONE OF THE OB RIVER AREA. Akad. Nauk. SSR Izv. Sib. Otd. Ser. Biol. Nauk. 10 (2): 46-53. [Ru.]

182.1

Lichti-Federovich, S., and Ritchie, J. C. 1965. CONTEMPORARY POLLEN SPECTRA IN CENTRAL CANADA. II. THE FOREST GRASSLAND TRANSITION IN MANITOBA. Pollen & Spores, Paris 7 (1), (63-87 + 2 tbls.). [30 refs. [E.f.e.] O.R.S.]
In general, the spectra reflected faithfully the zones they represented. Certain distortions of pollen spectra, especially those caused by the rapid deterioration of Poplar pollen, are discussed.

Ritchie, J. C. 1964. CONTRIBUTIONS TO THE HOLOCENE PALEOECOLOGY OF WEST CENTRAL CANADA. I. THE RIDING MOUNTAIN AREA. Canad. J. Bot. 42 (2), (181-96 + 5 photos). 29 refs. O.R.S.

Sangster, A. G., and Dale, H. M. 1964. POLLEN GRAIN PRESERVATION OF UNDER-REPRESENTED SPECIES IN FOSSIL SPECTRA. Canad. J. Bot. 42 (4): 437-49. 7 refs. O.R.S.
In general, species of the same genus behaved similarly.

182.2

Londo, G. 1974. SUCCESSIVE MAPPING OF DUNE SLACK VEGETATION. Vegetatio 29 (1): 51-61 [E., 15 ref. BLL]

182.3

Molchanov, Aleksandr Alekseevich, and Vznuzdaev, N. A. 1969. COMPLEX STUDY OF ASPEN ASSOCIATIONS INCLUDING STUDY OF MORPHOLOGICAL VARIATION. Adademiia nauk SSSR, Laboratoriia lesovedeniia Moskva, Nauka 74: 3. illus. [Ru.]

Podzharov, V. K., and Shchurevich, A. A. 1973. ALNUS GLUTINOSA, BETULA AND POPULUS STANDS IN A LOWLAND SWAMP. Lesoved Lesn Khoz 7: 168-170. [Ru.]

187 VEGETATION TYPES

Clonaru, A., Raduca, C., and Milea, I. 1970. [PRELIMINARY RESULTS FROM PLANTATIONS OF POPLAR AND WILLOW IN REED BEDS PROTECTED BY DYKES IN THE DANUBE DELTA.] Rev. Padurilor 85 (7), (342-7 + smries.). [Rum.g.e.f.ru.]

Georgesco, C. C. 1969. [THE FORESTS OF THE DANUBE DELTA.] Montes, Madrid 25 (147):229-35. [Span.]
The most important forest species are Populus spp., Fraxinus spp. and Quereus robur. In general, natural regeneration is satisfactory where grazing is prohibited.

Goettling, H. 1968. [FOREST COMMUNITIES OF THE INN FLOOD-PLAINS IN BAVARIA.] Forstwiss. Forsch. No. 29, pp. 64 + 4 maps. [6 pp. of refs. [G.].]

Seibert, P. 1966. [THE VEGETATION OF THE ISAR FLOOD-PLAIN TO THE N. OF MUNICH, AND HUMAN INFLUENCE UPON IT.] Beyerische Landesstelle fur Gewasserkunde, Munich. [n.d.] pp. 123. [G.] From review in Allg. Forstzeitschr. 21 (10). (175-6, 178). [G.]
Largely concerned with floodplain forest types composed of Alnus spp., Populus spp., Salix spp., etc., and the succession by which they came into being.

Yurkevich, I. D., and Petrov, E. G. 1971. [TYPES AND ASSOCIATIONS OF BIRCH FORESTS ON UNDRAINED TRANSITIONAL BOGS AND FENS.] Lesoved. (1), (12-23). [Ru.e., 11 ref.]
Distinguishes and describes 5 types and 13 associations of Betula pubescens forests in Belorussia.

2 SILVICULTURE

Anonymous. 1967. [POPLAR GROWING IN HUNGARY] Erdo 16 (7), (289-329). [6 refs. [Hu.ru.g.].]

Anonymous. 1967. POPLAR GROWING IN HUNGARY. Transl. Dep. Fish. For. Can. No. OOFF-75, 1969. pp. 84. [Transl. from Erdo 16 (7), (289-329). [See F.A. 29 No. 5404.] Limited distribution.]

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Discusses results of trials with 50 taxa, including Populus trichocarpa cultivars of different ages and origins (chiefly western North America), other species, clones of the 'Berolinensis' and 'Generosa' complexes, and hybrids produced by Stout and Schreiner and by Wettstein.

Frohlich, H. J. 1965. UBER ANBAUEIGNUNG VON BALSAMPAPPELN UND BALSAMKREU-ZUNGEN. Forstarch., Hann. 36 (6/7): 132-141, 8 Abb., 12 graph.Darst., 7 Tab., 24 Lit.Ang.

Frohlich, H. J., and Grosscurth, W. 1973. [THE BREEDING, CULTIVATION AND PERFORMANCE OF POPLARS.] Mitteilungen der Hessischen Landesforstverwaltung No. 10, 267 pp. + 1 tab. [De.e., 142 ref.]
Discusses the results of prolonged observations and measurements made in Poplar nurseries and in 31 trial plantings established in 1950-1966 on a great variety of W. German sites.

Gancev, P. [Ganchev, P.] 1974. [HYBRIDIZATION OF SOME POPULUS SPP. OF THE SECTION LEUCE.] Topola 18/19 (103/106): 89-94. [Sh.e.ru., 10 ref.]
Reports the morphology, phenology and increment of 9-year-old progeny of the cross P. alba x P. tremula and 3-year-old progeny of P. tremula x P. tremuloides.

Ganchev, A., and Ganchev, P. 1971. [GROWTH AND YIELD OF SOME POPLARS IN THE YAMBOL COLLECTION.] Gorsko Stopanstvo 27 (7), (26-30). [Bulg.]
Discusses 11 different Poplar clones and hybrids at age 11 years in plantations at spacings of 3 X 3, 4 X 4, 5 X 5, and 6 X 6 m in Bulgaria.

Garbaye, J., and Leroy, P. 1973. [BEHAVIOUR OF ELEVEN POPLAR CLONES IN SEVEN NURSERIES IN THE NORTH-EAST [OF FRANCE].] Revue Forestiere Francaise 25 (4) 299-307 [F., 7 ref.]

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Golovcanskij, I. N. 1970. [A HYBRID POPLAR FOR FLOOD-PLAINS IN THE STEPPE ZONE.] Lesn. Hoz. (11), (36-9). [Ru.]

Goor, C. P. van, and Koster, R. 1969. [EXPECTATIONS FOR NEW POPLAR CLONES.] Populier, Wageningen 6 (3), (43-7). [Du.]
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Grigor'ev, A. G. 1969. [HYBRID POPLARS IN THE CONDITIONS OF THE CRIMEAN STEPPE.] Bjull. Gos. Nikit. Bot. Sada (2), (3-6). [Ru., 4 refs. N.L.L.]
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Grosscurth, W. 1971. [AN ASSESSMENT OF THE SUITABILITY OF POPLAR CLONES OF THE SECTIONS AIGEIROS AND TACAMAHACA BASED ON 15 YEARS' OBSERVATIONS.] Thesis, Staatswirtschaftliche Fakultat der Universitat Munchen 187 pp. [De. From review in Forstarchiv 44, 161-162. D².]

Guldemond, J. L. 1966. [THE BALSAM POPLAR HYBRIDS POPULUS 'ANDROSCOGGIN', P. 'GENEVA' AND P. 'OXFORD'.] Ned. Bosb. Tijdschr. 38 (9), (323-30). [5 refs. [Du.du.e.].]

Hattemer, H. H. 1966. ERGEBNISSE EINES VERSUCHS MIT 16 PAPPELSORTEN NACH SIEBEN JAHREN. Holz-Zentralbl., Stuttg. 92: 153, S.2664.

Hattemer, H. H. 1967. [COMMENTS ON CERTIFICATION OF POPLAR CULTIVARS.] Repr. from Forstpflanzen-Forstsamen, Strassenhaus (2). pp. [7]. [31 refs. [G.g.e.].]
Publication of the specifications of the standard required for certification of clones is advocated.

Hattemer, H. H., and Langner, W. 1965. MITTEILUNG UBER EIN PRUFPROGRAMM FUR PAPPELKLONE. [COMMUNICATION ON A TESTING PROGRAMME FOR POPLAR CLONES.] Repr. from Forstpflanzen-Forstsamen, Strassenhaus (1). pp. [3]. 3 refs. [G.]
Describes a W. German testing programme for new selections, to be linked with the 'old-stock' trials by the use of the same standard varieties for the comparison.

Hattemer, H. H. von, Hinkelmann, K., and Maschning, E. 1965. FIRST RESULTS OF OPEN-FIELD EXPERIMENTS WITH BLACK POPLAR HYBRIDS. U.S. Forest Service, Washington. Transl. No. FS-537, pp. 8. 5 refs. Transl. from Zuchter 34 (6/7), 1964 (257-60).

Hausser, K., and Troeger, R. 1964. [FIRST RESULTS OF POPLAR VARIETAL AND FERTILIZER TRIALS ESTABLISHED IN S. WURTTEMBERG HOHENZOLLERN BETWEEN 1950 AND 1954.] Allg. Forst- u. Jagdztg. 135 (4; 5): 102-12; 113-25. 17 refs. [G.g.e.f.]
Presents data on height and diameter increment and root development from 25 trials involving the more common Black Poplar and other hybrids.

Herbignat, A. 1965. [CHOICE OF POPLAR CLONES: SPACING AND PRUNING.] Bull. Soc. For. Belg. 72 (7). (301-10). [F.]
Lists 7 clones for row planting and 17 for plantations in Belgium; discusses the economics of spacing (recommending 7 X 7 m.) and gives a generalized pruning schedule.

Herpka, I., and Markovic, J. 1974. [RESULTS OF STUDIES ON COMPARATIVE TRIALS OF POPLARS.] Topola 18/19 (103/106): 183-193. [Sh.e.ru.]
Reports a 13-year-old trial of 7 clones at wide spacing on an alluvial site in Yugoslavia.

Jamblinne, A. de (Jamblinne de Meux, A. de], Steenackers, V., Veldeman, R. 1974. [THE GROWTH OF POPLARS IN 1971, 1972 AND 1973. REPORT OF THE FIELD TRIALS WORKING GROUP [OF THE BELGIAN NATIONAL POPLAR COMMISSION].] Bulletin de la Societe Royale Forestiere de Belgique 81 (4) 188-206 [F., Nl]

Jamblinne de Meux, A. de, Veldeman, R., Steenackers, V. 1973. [THE FIELD-TRIALS WORKING GROUP OF THE [BELGIAN] NATIONAL POPLAR COMMISSION.] Bulletin de la Societe Royale Forestiere de Belgique 80 (3): 85-90 [F., Nl]
A progress report on the activity of the working group with data on increment and resistance to Marssonina brunnea for a number of clones under trial in Belgium.

Jenko, V. 1970. [THE FIRST FELLING OF POPLARS IN PLANTATIONS IN SLOVENIA.] Topola (81/82): 21-3. [Sh.e.]
Gives details of yields from fellings of small plantations.

Kopecky, F. 1969. INTRODUCTION OF NEW POPLAR HYBRIDS AND CLONES IN HUNGARY. [Pap.] 2nd FAO/IUFRO World Consult. For. Tree Breed., Washington No. FO-FTB-69-7/6, pp. 7. [F.e.]
Breeding and selection work with clones of sections Leuce and Aigeiros is described.

Koscielny, S., and Sekowski, B. 1965. [RESULTS OF POPLAR TRIALS IN THE GOLUCHOW ARBORETUM.] Rosczn. Dendrol. Polsk. Tow. Bot., Warsz. 19: 59-74. [Pol.f.f.]
Nine Poplar species and hybrids were established on moist alluvial soil, using 1-year stock in 1955. Data are tabulated on height and diameter classes in 1961 and 1962, and on height and diameter increment in 1960-62.

Krummsdorf, A. 1965. [RESULTS OF TRIALS OF POPLARS AND WILLOWS IN THE LEIPZIG AREA.] Arch. Forstw. 14 (2), (169-208). 23 refs. [G.g.ru.e.]

Lange, O. 1965. PAPPELARTEN UND PAPPELSORTEN UNTER BESONDERER BERUCKSICHTIGUNG IHRER ANBAUWURDIGKEIT IM NORDDEUTSCHEN RAUM. Forst-u.Holzwirt, Hann. 20, 12, 257-262, Lit. Ang.

Lange, O. 1969. [PLANTING OF BLACK POPLAR HYBRIDS WITH AN ADMIXTURE OF SOME BALSAM POPLARS IN THE SAUERLAND REGION.] Holzzucht, Reinbek 23 (3/4), (35-6). [G., 3 refs.]

Langner, W. 1971. [FIRST RESULTS OF THE SCHMALENBEK POPLAR TESTING PROGRAMME.] Allg. Forstzeitschr. 26 (39), (794-6). [De., 4 ref.]
[Cf. FA 27 No. 480.] Discusses 8-year height growth and stem form of three series of tests with 51 new and 5 old-stock varieties planted in 1963 as 2 + 1 plants, each on two test sites in N., NW or S. Germany.

Llubani, F. 1971 PRODUCTION OF SAPLINGS, THEIR USE IN AFFORESTATION WORK AND RESULTS FOR HYBRID POPLAR IN THE KRUJA AREA. Bulletini i Shkencave Bujqesore 10 (1): 147-160. [Albanian.ru.f.e. From Plant Breeding Abstracts 42, 9059.]
Presents tabulated data on the performance of five hybrids in Albania during 1967-70. The hybrids 'I-214' and 'I-154' and 'I-455' performed well.

Maisenhelder, L. C. 1970. EASTERN COTTONWOOD SELECTIONS OUTGROW HYBRIDS ON SOUTHERN SITES. J. For. 68 (5): 300-1. [1 ref.]
Commercial growers in the southern U.S.A. are advised to rely on native Populus selections for the present.

Maksaeva, L. D. 1970. [VARIETAL TRIALS OF POPLARS FOR GROWTH RATE AND HARDINESS IN THE MIDDLE DON REGION.] Sb. Naucn. Rabot Donsk. Nauc.-issled. Lesn. Opytn. St. (3), (14-28). [Ru. from abstr. in Referat. Z. 1970 (8.56.105). Ru. N.L.L.]
Gives results of 8 years' observations on plantings of 76 species and varieties on chernozem-like clay-loams on and above the flood-plain of the middle Don.

Milovanovic, M. 1970. [STUDY ON THE YIELD OF SOME POPLAR CLONES IN DONJE PODUNAVLE.] Topola 81/82: 24-6. [Sh.e.]
Compares measurements in 1965 with those in 1960.

Mottl, J., Mraz, K., and Polnar, M. 1968. [GROWTH OF POPLAR CLONES AT 3—12 YEARS ON TRIAL PLOTS IN BOHEMIA AND MORAVIA IN VARIOUS SOIL CONDITIONS.] Prace Vyzkum. Ust. Lesn. Hosp. Mysl., Zbraslav-Strnady No. 36: 119-48. [1 ref. [Cz.cz.ru.e.ru.e.].]
Gives detailed data in tables and graphs on soil types and growth characteristics for a wide range of clones in plantations established in 1953-62 on 21 greatly differing sites.

Mottl, J., and Polnar, M. 1968. [PRELIMINARY RESULTS AFTER 5-7 YEARS OF TRIALS WITH POPLAR CULTIVARS ON PERMANENT SAMPLE PLOTS.] Prace Vyzkum. Ust. Lesn. Hosp. Mysl., Zbraslav-Strnady No. 35, (111-41). [24 refs. [Cz.ru.e.ru.e.].]
So far, P. 'I-214' has done best on all sites except one. A final assessment is planned at 15—20 years.

Mraz, K. 1968. [SOIL TYPES AND INCREMENT OF YOUNG BLACK POPLAR HYBRIDS.] Arch. Forstw. 17 (3), (313-28). [18 refs. [G.g.ru.e.].]
In trial plantings on 12 flood-plain or upland sites in Czechoslovakia, varying greatly in soil type and structure, nutrient content, water regime and natural vegetation, height growth was affected many times more by site than by genetic variety.

Napalkov, N. V. 1964. [VARIETAL TESTS AND INTRODUCTION OF PROMISING POPLARS IN THE CENTRAL VOLGA REGION.] Lesn. Hoz. 17 (3), (30-2). [Ru.]
A summary assessment of 86 species, hybrids and ecotypes ('climatypes') tried since 1956 at the Tatar Forest Experiment Station.

Nikanorov, G. M. 1972. [POPLAR TRIALS IN MOLDAVIA.] Sb. rabot po les. kh-vu Moldavii, Mold. les. opyt. st. No. 6 (119-134). [Ru. From Referativnyi Zhurnal (1972) 12.56.86, 87, 89. Ru.]

Orlova, N. A. 1973. [GROWTH AND YIELD OF HYBRID POPLARS IN THE TOWN OF FRUNZE.] In Kul'tura lesnykh porod v Kirgizii. Frunze, USSR, Ilim. 30-35 [Ru., NLL]
Tabulates data on the height, d.b.h., and m.a.i. in height, and wood volume at 5 years for 85 clones in irrigated plantations at Frunze, Kirghizia.

Oultremont, Comte D., and Steenackers, V. 1973. [NEW POPLAR VARIETIES FOR VARIETAL TESTING. MINISTERIAL DECREE OF 21 APRIL 1972.] Bulletin de la Societe Royale Forestiere de Belgique 80 (3) 110-135 [F.Nl., 8 ref.]
Lists 12 Populus X euramericana [P. X 'canadensis'] clones already under test, and 15 P. X euramericana, P. trichocarpa, and P. trichocarpa X P. deltoides clones under observation in Belgium.

Persson, A. 1973. [A TRIAL WITH FAST-GROWING POPULUS SPECIES.] Rapporter och Uppsatser, Institutionen for Skogsproduktion No. 27, 34 pp. [Sv.e., 20 ref.]
Reports results after 24 years.

etrov, M. 1964. [STUDY OF CERTAIN POPLAR CLONES LONG THE DANUBE.] Gorskostop. Nauka, Sofija 1 (3), (29-44). 2 refs. [Bulg.ru.g.]
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oller, K. J. 1970. RESULT OF A PROJECT FOR BREEDING OPLAR CULTIVARS FOR MANITOBA. Extr. from Proc. 12th tg. Comm. For. Tree Breeding Can. Part 2, (135-44).
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chreiner, E. J. 1972. PROCEDURE FOR SELECTION OF HY-RID POPLAR CLONES FOR COMMERCIAL TRIALS IN THE ORTHEASTERN REGION [OF THE USA]. In Proceedings, 19th ortheastern Forest Tree Improvement Conference 1971. 108-119 E.]

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heikh, M. I. 1972. HYBRID POPLAR PLANTATION IN WEST AKISTAN. Peshawar, Pakistan, Pakistan Forest Institute. iv + 75 p. + 3 tab. [E.]
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heikh, M. I. and Hussain, R. W. 1972. POPLAR CLONAL TRIALS N WEST PAKISTAN—AN INTERIM REPORT. Pakistan Journal of orestry 22 (3): 301-322 [E., 7 ref.]

hipman, R. D., and Baldwin, R. C. 1966. PLANTED HYBRID OPLAR CUTTINGS SHOW VARIABLE RESISTANCE TO ROUGHT. Tree Plant. Notes No. 79, (23-8). [1 ref.]
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iddiqui, K. M., and Hussain, R. W. 1966. SOME PRELIMINARY CLIMINATION TRIALS WITH HYBRID POPLARS. Pakistan J. For. 16 (2), (138-54). [6 refs.]

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Describes highly promising trials with 15 hybrids and clones of Black Poplars and 6 of Balsam Poplars.

ingh, B., Mathur, R. B., and Srivastava, R. C. 1973. RESULTS OF 'ERFORMANCE OF SOME ITALIAN, AMERICAN AND AUSTRALIAN CLONES OF POPLARS IN TARAI SOILS OF UTTAR PRADESH. [Forestry Conference, Dehra Dun.]

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ion, D. S., and Cho, R. M. 1966. [THE GROWTH PER-FORMANCE OF POPULUS ALBA X P. GLANDULOSA F_1 HYBRID.] Research Reports. Office of Rural Development. Suwon 9 (2), (109-16). [15 refs. [Kor.kor.e.e.].]
P. alba X P. glandulosa has proved outstanding in hybrid vigour, and is considered very suitable for afforestation of poor, acid soils on slopes.

Son, D. S. 1974. [THE GROWTH PERFORMANCE OF POPULUS NIGRA VAR. ITALICA X POPULUS MAXIMOWICZII F_1.] Research Report of the Institute of Forest Genetics, Korea No. 11, 61-67 [Kor.e., 8 ref.]

Son, D. S. and Chung, S. B. 1972. [THE GROWTH PERFORMANCE AND SPECIFIC GRAVITY OF HYBRID POPLAR [IN KOREA].] Research Report of the Institute of Forest Genetics, Korea No. 9, 9-16 [Kor.e., 25 ref.]
Variation in sp.gr. was high among individual trees as well as between plantation sites. In bark type the hybrids seemed to resemble their ♂ rather than their ♀ parent.

Stecki, Z. 1967. [STUDIES ON THE VARIATION AND GROWTH RATES OF POPLAR SEEDLINGS AND VEGETATIVELY PROPAGATED HYBRIDS.] Arboretum Kornickie, Poznan 12 (283-328). [28 refs. [Pol.e.ru].]
Results indicated great variation in height and diameter, not only in populations of sexual hybrids but also within a clone. Reliable differences in growth between clones, and also differences in their response to weather in different years were demonstrated.

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Summarizes trials with several hybrid Poplars during 1961-65 and includes data on rate of growth and yield, and protection from diseases, pests and fire.

Vibe, G. G. 1968. [WINTER HARDINESS AND GROWTH OF INTRODUCED HYBRID POPLARS IN THE SOUTH OF THE TRANS- URALS FOREST-STEPPE.] Bjull. Glavn. Bot. Sada, Moskva No. 69, (86-8). [8 refs. [Ru.] N.L.L.]
The hardiest hybrids were obtained from crosses involving Populus suaveolens, P. balsamifera, P. nigra and P. tremula; hybrids obtained from crosses involving P. nigra var. italica were much less winter-hardy.

Vojtus, M. 1965. PRESENT RESULTS OF RESEARCH ON SITE REQUIREMENTS OF SOME EUROAMERICAN POPLARS IN SLOVAKIA. Commun. Inst. For. Csl. 4, (175-86 + 1 tbl.) 17 refs. [E.e.ru.]
'Marilandica', and P. 'Gelrica' grew best and showed the greatest disease resistance, while P. 'Serotina' and P. 'Fremontii' were consistently slower in growth and showed a poor disease resistance.

Wendel, G. W. 1972. RESULTS OF A 20-YEAR TEST OF HYBRID POPLARS IN WEST VIRGINIA. USDA Forest Service Research Paper, Northeastern Forest Experiment Station No. NE-237, 5 pp. [E., 5 ref.]

Werner, H. 1969. [JUVENILE GROWTH OF VARIOUS POPLAR SPECIES AND VARIETIES AT REICHENBERG POPULETUM.] Mitt. Ver. Forstl. Standortskunde Forst-pflZucht. No. 19, (67-71). [G.]
Presents data on height, diam., and volume at age 10 for 46 clones planted as 2-year-olds on a deep, humous alluvial loam in the Neckar growth region, S.W. Germany.

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Wolski, B. 1966. [ANALYSIS OF THE GROWTH OF SOME POPLAR HYBRIDS AND THEIR SUITABILITY FOR PLANTING IN THE POPRAD VALLEY.] Sylwan 110 (11), (65-72), [6 refs. [Pol.ru.e.].]

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Proposes a plan for Willows and Poplars, using simple correlations and analysis of variance.

Zsombor, F. 1974. [SOME RESULTS FROM TRIALS OF APPROVED VARIETIES OF POPLARS.] Erdo 23 (8): 379-382. [Hu.ru.e.]
Data are presented from 12-year-old trials of Populus 'I-214', P.

'O.P. 229' and P. 'Robusta' showing the changes, in successive annual rings, in volume increment, ring width, wood density, and fibre length.

232.2

Bura, D. 1966. [GROWING SOYA IN POPLAR PLANTATIONS.] Topola, Beograd 10 (57/58), (28-31). [Serb.f.]
Intercropping in plantations 1-3 years old has given high yields of soya. Soya also has a favourable effect on growth of Poplars.

Galecic, M. 1972. MECHANIZED STUMP REMOVAL IN PLANTATIONS OF POPLAR AND OTHER WOODY SPECIES WITH THE LEVACEPI-ELLETARI MACHINE ON AN MF 1080 TRACTOR. Sumarstvo 25 (9/10): 3-10.

Gojkovic, G. 1974. [USE OF HERBICIDES IN PREPARING POPLAR FELLINGS FOR REPLANTING.] Topola 18 (100/101): 128-130 [Sh.e., 12 ref.]
Describes a series of trials in Yugoslavia with herbicides to prepare clear-felled areas of Poplar plantation for replanting with Populus 'I-214'.

Mackiewicz, S. 1965. [INTEGRATED MECHANIZATION IN CLEARING AND PREPARING THE SITE FOR POPLAR PLANTATIONS.] Las polski 39 (4): 11-3. [Pol.]
Details are given of operations and equipment used in felling, cutting down old tall stumps, splitting of stumps in the ground, stump pulling and skidding of stumpwood, clearing and levelling, and deep cultivation.

Roersch, J. C. 1966. [POPLARS AND AGRICULTURE. 1. RESULTS OF INTERCROPPING.] Populier, Wageningen 3 (1): 17-9. [Du.]
Gives some figures for the financial yields from crops grown between rows of P. 'Robusta', P. 'Gelrica' and P. 'Serotina'.

Toth, B. 1970. [POPLAR CULTIVATION ON STATE FARMS IN THE NYIRSEG DISTRICT.] Erdo 19 (10): 477-478. [Hu.]

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Cellerino, G. P. 1974. CHEMICAL WEED CONTROL OF A NEWLY PLANTED POPLAR NURSERY. Cellul. Carta 25 (5): 38-44. [It.e.]

Simon, M. 1965. [THE RAISING OF LARGE TRANSPLANTS FOR INTENSIVE POPLAR CULTIVATION.] Erdo 14 (1): 1-6. 3 refs. 2 tbls. [Hu.ru.g.]

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Bowersox, T. W. 1972. HYBRID POPLARS IN ROWS SUPERIOR IN FIBER YIELD. Sci. in Agr. 19 (4): 4-5.

Schreiner, E. J. 1974. POPULUS L. – POPLAR. U. S., Dept. of Agri. Agric. Handb. U. S. Dep. Agric. 450: 645-655.

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232.312

Harder, M. L. 1970. PROCEDURES FOR COLLECTION AND EXTRACTION OF POPULUS SEED. Genet. Physiol. Note Inst. Paper Chem. No. 9, pp. 3. [1 ref.]

Sergeenkov, F. I. 1968. A MACHINE FOR EXTRACTING POPLAR SEEDS AND PROCESSING (OTHER) SEEDS. Transl. Dep. For. Can. No. 185, pp. 14. [Transl. from Lesn. Hoz. 1966 19 (11), (36-41).]

Sergeenkov, F. I. 1966. [A MACHINE FOR EXTRACTING POPLAR SEEDS, AND FOR PROCESSING [OTHER] MATERIAL FOR SEED.] Lesn. Hoz. 19 (11), (36-47). [Ru.]
Describes drum-type electric seed extractor capable of dealing with catkins, legumes, pods, infructescences, cones, berries, samaras, and winged conifer seeds.

232.314

Schmidt, W. [Editor]. 1966. [EASLY TESTING OF PROVENANCES AND THE PRESENT INEFFECTIVE SYSTEM OF SEED CERTIFICATION.] Forstpflanzen-Forstsamen, Strassenhaus (3;4), (25-46; 5-39); 1967 (2;3), (5-36; 4-19). [Many refs. [G.] F.C.A.H.]
A series of 19 papers (two in French, the rest in German) in the context of a controversy on certification of seed by phenotype under German law.

232.32

Anonymous. 1968. LISTE DER BAUMSCHULEN UND KENNZEICHNUNG DER SORTEN, DENEN DAS MARKEN-ETIKETT FUR PAPPEL- UND BAUMWEIDEN-PFLANZEN NACH DEN NEUEN QUALITATSBESTIMMUNGEN ZUERKANNT WURDE. Holzzucht, Reinbek 22, 4, 50-51.

Kovacs, J. 1973. [EXPERIMENTS ON CHEMICAL WEEDING IN ONE-YEAR OLD MIXED CONIFEROUS PLANTATION.] Erdo 22 (9): 412-414. [Hu.]

Papp, L. 1971. UPDATING THE PRODUCTION OF FORESTRY PROPAGATION MATERIAL. Erdeszeti Kutatasok 67 (2): 145-157. [E., 10 ref.]
Summarizes developments in nursery management in Hungary during the decade 1958-67.

Vidali, E. 1968. [RESEARCH AND ACHIEVEMENTS IN THE MECHANIZATION OF CULTIVATION OF POPLAR, EUCALYPT AND CONIFER NURSERIES.] Cellulosa e Carta 19 (3): 27-36. [It.f.e.g.]
Describes and illustrates machinery recently developed by the E.N.C.C. to facilitate economy of labour and cheaper production of nursery stock.

Westeinde, J. C. van 't. 1964/65. [POPLAR IN THE NURSERY.] Populier 1 (2): 5, and 2 (1): 5-6.

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Alexandres, S. G. 1968. [SOIL STUDIES IN SOME MAJOR FOREST NURSERIES [IN GREECE].] Deltion Ereunon, Ypourgeion Georgias Institouton Dasikon Ereunon, Thessalonike No. 23, pp. 44 + 2 tbls. [88 refs. [Gk.gk.g.g.] 6 figs. 2 tbls.]

Frison, G. 1974. [USE OF FERTILIZERS ON POPULUS 'I-214' IN THE NURSERY.] Cellulosa e Carta 25 (7/8) 3-20 [It.f.e.de., 21 ref.]
It is concluded that, in general, use of fertilizers in Poplar nurseries is beneficial only on poor soils.

Giulimondi, G. 1972. [NITROGEN FERTILIZING OF POPLARS IN NURSERIES.] Cellulosa e Carta 23 (8): 25-33. [It.f.e.de.]

Jaro, Z. 1965. [FERTILIZING IN FORESTRY.] Ungarische Forstwissenschaftliche Rundschau, Budapest (25-39). [G.] [2 tbls. 1 map.]
Includes tables summarizing contents of N, P and K in Populus alba and various Black Poplar hybrids at different sites and ages.

Oliveira, A. F. 1966. SOME ASPECTS OF THE MINERAL NUTRITION OF POPLAR NURSERIES. Agri Digest, Brussels (9), (2-11). [11 refs. [E.f.span.] H.S.B.]
Nursery stock of Populus euramericana clones 'A-80' and 'I-214' was sampled one year after planting as cuttings, measured, and chemically analysed, and the nursery soil was also analysed.

Sluhaj, S. I. 1965. [NUTRITION AND FERTILIZING OF YOUNG WOODY PLANTS.] 'Naukova Dumka', Kiev. pp. 303. [Ru. 24 pp. of refs. N.L.L.]
A monograph on the nutrition and fertilizing of nursery seedlings, and on the fertilizing of Poplar plantations.

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Meiden, H. A. van der, and Overbeek, J. F. L. 1967. SPACING OF POPLAR CUTTINGS IN THE NURSERY. Populier 4 (1): 5-9. [Du.]

Read, R. A., and Bagley, W. T. 1967. RESPONSE OF TREE SEEDLINGS TO EXTENDED PHOTOPERIODS. U.S. For. Serv. Res. Pap. Rocky Mt. For. Range Exp. Sta. No. RM-30, pp. 16. [7 refs.]
A study of artificial-light treatment to shorten the nursery production period of planting stock in the central and northern Great Plains.

232.324

Anonymous. 1968. [THE USE OF PLOUGHS FOR LIFTING POPLARS IN NURSERIES]. Sozial. Forstw. Berl. 18 (8): 251-3. [G.] [5 photos. 2 tbls.]
Briefly describes 4 ploughs and gives technical data and recommendations for their use.

Popescu, N. 1970. ON THE TECHNIQUE OF POPLAR SEEDLINGS IN NURSERY FOR ALIGNMENTS. Rev. Padurilor 85 (9): 464-466. [Ra.]

Zabielski, S. 1970. [THE INFLUENCE OF SEEDLING PREPARATORY TREATMENTS AND WAYS OF TRANSPLANTING ON THE SUCCESS OF POPLAR CULTURE.] Poznan Tow Przyjaciol Nauk Wydz Nauk Roln Lesn Prace 30: 359-404. [Pol.]

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Anonymous. 1972. [CHEMICAL WEEDING OF [POPLAR] NURSERIES.] Revue Forestiere Francaise 24 (1): 52. [F.]

Liani, A. 1974. [PRELIMINARY RESULTS OF A COMPARISON BETWEEN IRRIGATION BY SPRINKLER AND IRRIGATION BY DRIP-FEED IN A POPLAR NURSERY.] Cellulosa e Carta 25 (7/8): 37-52. [It.f.e.du., 24 ref.]

Magnani, G. 1969. [WEEDING IN TWO-YEAR-OLD POPLAR NURSERIES.] Cellulosa e Carta 20 (1), (13-20). [It.it.f.e.g.]
Successful results are reported from chemical weeding trials in 2-year-old Poplar nurseries in central and southern Italy.

Papadopol, C. S. 1969. [THE INFLUENCE OF IRRIGATION METHODS IN NURSERIES ON THE GROWTH AND EVAPOTRANSPIRATION OF POPLAR SEEDLINGS.] Rev. Padurilor 84 (7), (323-8 + smries.). [9 refs. [Ro.f.g.e.ru.]

Papadopol, C. S. 1969. [THE INFLUENCE OF RATE OF IRRIGATION ON WATER CONSUMPTION AND GROWTH OF POPLAR IN THE NURSERY.] Rev. Padurilor 84 (9), (441-7 + smries.). [Ro.e.f.g.ru., 6 refs.]
Nursery experiments were made on 1-year-old hybrid Black Poplars (11 varieties and clones), to determine the optimum rate of irrigation.

Sferdean, G. 1974. [THE USE OF HERBICIDES AT THE RECAS FOREST NURSERY [IN W. RUMANIA].] Revista Padurilor – Industria Lemnului, Silvicultura si Exploatarea Padurilor 89 (3): 127-130 [Ro. ,2 ref.]
Discusses trials during 1968-73.

Shimanskii, P. S. 1971. TESTING RADOKOR AND PROMETRYNE IN POPLAR PLANTATIONS. Lesokhoz Nauka Prakt 20: 92-95. [Ru.]

Tromp, P. H. M. 1964. CHEMICAL WEED CONTROL BEFORE AND AFTER THE ESTABLISHMENT OF POPLAR PLANTATIONS. Populier 1 (1): 9-11. [Du.]

Vidali, E. 1969. [TRIALS OF MULCHING IN POPLAR NURSERIES.] Cellulosa e Carta 20 (1), (21-5). [It.it.f.e.g.]
Comparative data (tabulated) on the diameter growth after two growing seasons of Poplars mulched with black plastic and unmulched indicate that the mulching increases the growth rate and should reduce costs.

232.326

Castellani, E., Sekawin, M., and Frison, G. 1967. [EXPERIMENTS IN THE USE OF GRAFTING FOR THE PROPAGATION OF POPLARS.] Proc. 14th Congr. Int. Union For. Res. Organ., Munich 1967 Pt. III, Sect. 22, (161-7). [7 refs. [F.f.e.g.]
Presents preliminary results of trials in grafting clones of Populus deltoides resistant to Marssonina brunnea but not easy to root.

Gombkoto, G., and Bercsek, P. 1968. STIMULATION OF ROOT FORMATION ON OLDER TREES BEFORE TRANSPLANTING. Kerteszeti es Szoleszeti Foiskola Kozlem. 32 (5, part 1), (97-109). [3 refs. Hu.E.Ru. From abstr. in Hort. Abstr. 1970 40 (2), (No. 4469).]
Root pruning of Populus stimulated the formation of new roots on 12- to 14-year-old trees.

Knezevic, I. 1967. [ADVANTAGES OF PARTIAL PRUNING OF POPLAR PLANTS STILL STANDING IN THE NURSERY, BEFORE LIFTING.] Topola, Beograd 11 (65/66), (15-6). [3 refs. [Serb.f.].]
Describes the economic advantages of pruning 2/3 Poplar plants before lifting them for planting out.

232.327

Gergacz, J. 1969. PROTECTION OF POPLAR PROPAGATING STOCK. Erdo 18 (7): 295-298. [Hu.]

Vidali, E. 1972. PROTECTION TREATMENTS OF POPLAR PLANTATIONS AGAINST INSECTS: YEAR 1971. Cellulosa e Carta 23 (1): 31-36. [It.e.]

232.328

Anonymous. 1965. EXPERIMENT ON PLANTING OF POPLAR CUTTINGS DURING RAINS. Annual Research Report- Sal Region for 1965-66, U.P. Forest Dept. Nainital.

Anonymous. 1969. PLANT STORAGE STUDIES: HARDWOOD CUTTINGS. Extr. from Summ. Rep. Tree Nursery Sask. (19).
Poplar and Willow cuttings given a captan dip and stored in polythene bags at 24°F, rooted as well in the spring as cuttings that had been heeled in outdoors. Cuttings stored at 35° failed to root.

Bloomberg, W. J. 1964. SOME FACTORS IN THE DEVELOPMENT OF CALLUS IN POPLAR CUTTINGS. For. Chron. 40 (4), (509-11). 4 refs.
The effect on callus production of temperature, moisture content of the cutting, and location within the shoot and cutting were investigated.

Cernjak, L. V. 1970. [ANATOMICAL CHANGES DURING ROOT FORMATION IN POPLARS OF SECTION LEUCE.] Bjull. Glavn. Bot. Sada No. 75, (100-4). [Ru., 4 refs. N.L.L.]
Anatomical studies were made periodically to determine why cuttings of Poplars in this section are difficult to root.

Chalupa, V. 1974. CONTROL OF ROOT AND SHOOT FORMATION AND PRODUCTION OF TREES FROM POPLAR CALLUS. Biologia Plantarum 16 (4): 316-320. [E., 7 ref. ORS]

Dubina, B. V. 1967. [PROPAGATION OF CERTAIN SPECIES AND FORMS OF POPLARS BY LIGNIFIED CUTTINGS.] In Sbornik Rabot molodyh ucenyh AN MoldSSr. Kishinev. 1966. pp. 122-4 [[Ru.] from abstr. in Referat. Z., Moskva (6.56.161). [Ru.] I.F.B.]
Studies on cuttings of 15 species and 2 forms showed that most rooted in water in 14-20 days, regardless of the time of year when the cuttings were taken.

Girouard, R. M. 1967. ANATOMY OF ADVENTITIOUS ROOT FORMATION IN STEM CUTTINGS. Proc. Pl. Propag. Soc. 17, (289-302). [38 refs. E.M.B.]

Haelters, J. 1973. [RESEARCH AND DEVELOPMENT WORK ON POPLAR IN THE EASTERN QUEBEC REGION. III. REVIEW OF EQUIPMENT FOR MECHANIZING THE PRODUCTION OF POPLAR CUTTINGS IN THE NURSERY.] Guide, Service de la Recherche, Ministere des Terres et Forets, Quebec No. 3, 57 pp. + smries. [F., 4 ref.]
Reviews the various types of equipment available for use in mechanizing the production of Poplar cuttings in nurseries, and describes the main stages in the production process.

Hafeez, M., and Sheikh, M. I. 1973. EFFECT OF VARIOUS FACTORS ON ROOTING OF POPLARS IN PAKISTAN. Pakistan Journal of Forestry 23 (3): 227-234 [E.]
Studies are reported of the effects of different soils, types of cuttings, coating of the ends of the cuttings with wax, frequency of

irrigation, and season of planting, on the rooting ability of five clones of Populus deltoides and one of P. X euramericana.

Hejmanowski, S. 1966. [EFFECT OF THE METHOD OF MAKING THE LOWER CUT ON THE QUALITY OF POPLAR CUTTINGS.] Prace Inst. Bad. Lesn. No. 309, (31-60). [19 refs. [Pol.ru.g.].]
Statistical evaluation of rooting and height growth showed that the 45° cut 2-3 mm. above a bud was best.

Hejmanowski, S. 1974. [THE USEFULNESS OF TERMINAL POPLAR CUTTINGS OF VARIOUS LENGTHS.] Prace Instytutu Badawczego Lesnictwa No. 445/449, 3-24 [Pol.ru.du., 13 ref.]
In investigations on various sites, terminal-shoot cuttings 20, 30, 40, and 50 cm long were taken from 8 different cultivars. Rooting depended primarily on the soil conditions in the nursery.

Hocking, D. 1970. SEMESAN FUNGICIDAL DIP CONTROLS CANKER DISEASES OF POPLAR CUTTINGS IN ALBERTA. Tree Plant. Notes 21 (3), (18-20). [9 refs.]

Iersel, H. van. 1971. [MECHANIZATION IN THE PRODUCTION OF POPLAR PLANTING STOCK.] Populier 8 (5), (93-4). [Nl]
A short general account of the making, storing and planting of cuttings in Holland.

Iersel, H. van. 1972. [MECHANIZATION IN THE PRODUCTION OF POPLAR PLANTING STOCK.] Populier 9 (1), (17). [Nl]
Describes planting of cuttings, weed control, insect and disease control, lifting, grading, certification, etc.

Jansen, E. C. 1974. [THE SPACING OF CUTTINGS FOR THE PRODUCTION OF ONE-YEAR-OLD POPLAR PLANTS WHICH MEET THE MINIMUM REQUIREMENTS SET BY THE EEC AND THE MINIMUM DEMANDS OF THE NAKB.] Populier 11 (1): 13-14. [Du.]

Janson, L. 1967. [THE VEGETATIVE PROPAGATION OF POPLARS OF SECTION LEUCE.] Proc. 14th Congr. Int. Union For. Res. Organ., Munich 1967 Pt. III, Sect. 22, (205-23). [G.]
Results of investigations into the influence of depth of planting, temperature and thickness of the cutting on the development of root cuttings.

Jobling, J. 1970. ASPECTS OF PROPAGATION IN FORESTRY. Combined Proceedings, International Plant Propagators' Society 20: 342-351 [E., EMB]
Discusses the methods of propagation by cuttings commonly practised in forest tree nurseries in Britain, and briefly reviews research in progress.

Kis-Toth, T. 1965. [GOOD SOIL CULTIVATION – APPLICATION OF A SUCCESSFUL METHOD OF ROOTING CUTTINGS.] Erdo 14 (9), (393-6). [Hu.ru.g.]
Describes methods of cultivation designed to achieve an adequate supply of 1-year-old rooted cuttings to be used as stools for further vegetative propagation.

Kolster, H. W. 1970. EIN- UND MEHRJAHRIGE PAPPELPFLANZEN UND -SETZSTANGEN. Holzzucht, Reinbek 24 (4): 33-40, [18 Abb., 13 Tab.]

Kolster, H. W. 1974. [WATER TREATMENT OF LONG POPLAR CUTTINGS.] Populier 11 (4): 71-72 [Nl, 2 ref.]

Koster, R. 1968. OUTDOOR PROPAGATION OF POPULUS DELTOIDES, BALSAM POPLARS AND HYBRIDS FROM LEAF CUTTINGS. Report for the Session of the International Poplar Commission of FAO at Montreal, [E.]

Koster, R. 1968. [PROPAGATION OF POPULUS DELTOIDES, BALSAM POPLARS, AND HYBRID POPLARS IN THE OPEN FROM SOFTWOOD CUTTINGS.] Populier, Wageningen 5 (4), (66-8 + front cover). [Du.du.]
Describes experience with growing softwood cuttings in cold frames under mist.

Lattke, H. 1970. [MIST-SPRAY PROPAGATION OF SALICACEAE NOT EASILY GROWN FROM CUTTINGS: NEW RESULTS.] Sozial. Forstw. 20 (6): 172-3, 181. [G.]

Lepisto, M. 1972. INCREASINGLY BETTER RESULTS IN PLANTING CUTTINGS. Translation, Environment Canada NO OOENV TR 153, 4 pp. [E., Transl. from Metsalehti (1971) No. 49 Fin.]

McAlpine, R. G. 1966. VEGETATIVE PROPAGATION METHODS FOR HARDWOODS. Proc. 8th Sth. Conf. For. Tree Impr. Savannah, Ga. (14-20). [18 refs.]
Reviews experience in the U.S.A. of propagation by (1) grafting, (2) budding, (3) air-layering, (4) stem- and (5) root-cuttings, and discusses the merits of these techniques.

Meer, W. Z. van der. 1967. [VEGETATIVE PROPAGATION OF AIGEIROS POPLARS.] Populier, Wageningen 4 (1), (8-10). [1 ref [Du.].]

Nicolae, C. 1970. [THE DEVELOPMENT OF PLANTS OF POPULUS 'ROBUSTA' CLONE R.16, OBTAINED FROM CUTTINGS TAKEN FROM DIFFERENT PARTS OF THE SHOOT AND PREPARED BY DIFFERENT TOOLS.] Rev. Padurilor 85 (7), (347-50). [Ro., 2 refs.]

Panetsos, K. P. 1970. [EFFECT OF THE DIAMETER OF CUTTINGS ON THE GROWTH AND SELECTION OF POPLAR CLONES IN THE NURSERY.] Bulletin, Forest Research Institute Ministry of Agriculture, Athens No. 39, pp. 32. [G.e., 19 ref.]
Compares cuttings, 20 cm. long and 6-10, 10-14, 14-18 and 18-22 mm in diameter, of 12 clones and 2 species in the production of 1/1 and 2/2 plants.

Papp, L. 1970. [MODERNIZING THE RAISING OF PLANTING STOCK OF HYBRID BLACK POPLARS IN HUNGARY.] Erdesz Kutatas. 66, (39-46). [Du.]
Nursery technique, spacing, etc. are discussed, with mention of crop rotation in the regional nurseries of green manure, Poplars, and other hardwoods.

Papp, L. 1970. [POSSIBILITIES FOR THE CENTRALIZED PRODUCTION OF POPLAR CUTTINGS [IN HUNGARY].] Erdo 19 (1), (26-33). [Hu.ru.e.]
Outlines a plan for 3 central stoolbed plantations to provide certified material to Poplar nurseries in 16 districts.

Philippis, A. de. 1967. FACTORS AFFECTING THE ROOTING OF POPLARS. Proc. 14th Congr. Int. Union For. Res. Organ. Munich 1967 Pt. III, Sect. 22, (156-60). [E.]

Ragonese, A. E., Rial Alberti, F., and Sonvico, V. A. 1968 [ROOTINGS OF CUTTINGS OF SOME CULTIVARS OF WILLOW AND POPLAR.] Idia: Supl. for. No. 5, 1968/1969 (89-106) [Span.e., 8 refs.]

Rubtov, S. 1964. [THE BEHAVIOUR OF POPLAR PLANTS DERIVED FROM CUTTINGS PLANTED HORIZONTALLY.] Rev. Padurilor 79 (12), (702-3). 1 ref. [Ro.]

Schmid, A., and Schurter, R. 1973. [EFFECT OF ETHYLENE ON THE ROOTING OF LIGNIFIED CUTTINGS OF POPULUS TREMULA AND P. NIGRA.] Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, France, D 276 (8): 1293-1296 [F., 10 ref. ORS]
Describes experiments showing that ethylene promotes the formation of adventitious roots on lignified cuttings and that IBA stimulates this action of ethylene.

Sekawin, M. 1969. [PROPAGATION OF POPLAR.] [Pap.] 2nd FAO/IUFRO World Consult. For. Tree Breed., Washington 1969 No. FO-FTB-69-11/5, pp. 23. [21 refs. [F.f.e.].]

Sekawin, M. 1970. [POPLAR PROPAGATION.] Cellulosa e Carta 21 (3): 45-53. [It.]

Sekawin, M. 1972. [A RAPID METHOD FOR DETERMINING THE ROOTING ABILITY OF POPLAR CUTTINGS.] Cellulosa e Carta 23 (10): 16-20 [It.f.e.du., 2 ref.]
A close correlation was found between the speed of water loss from cuttings of 5 clones of Poplar of the section Aigeiros and their average survival in the nursery.

Sekawin, M. 1974. [MORE ON THE CORRELATION BETWEEN SPEED OF WATER LOSS AND ROOTING OF POPLAR CUTTINGS.] Cellulosa e Carta 25 (1): 3-11 [It.f.e.du., 1 ref.]

Singh, B. 1973. EFFECT OF DIFFERENT LENGTHS OF CUTTINGS ON GROWTH AND SURVIVAL OF POPLARS IN NURSERY. Forestry Conference, Dec. 1973, Dehra Dun.

Viart, M. 1965. [PRELIMINARY NOTE ON THE ROOTING CAPACITY OF SUCCESSIVE NODES [IN SHOOTS] OF CERTAIN POPLARS.] Bull. Serv. Cult. Etud. Peuplier et Saule, Paris (2), (38-48). 2 refs. [F.]
Rooting response was best in cuttings that bore a bud formed in the 5th, 7th, or 13th position from the base.

Wareing, P. F., and Smith, N. G. 1964. PHYSIOLOGICAL STUDIES ON THE ROOTING OF CUTTINGS. Extr. from Rep. For. Res. For. Comm., Lond. 1962/63, (118-21).

Wareing, P. F., and Smith, N. G. 1965. PHYSIOLOGICAL STUDIES ON THE ROOTING OF CUTTINGS. Extr. from Rep. For. Res. For. Comm., Lond. 1963/64, (130-2).
A study of the endogenous hormones of Populus X robusta with special reference to the rooting of leafy and hardwood cuttings.

Zabielski, S. 1965. [THE USEFULNESS OF TERMINAL CUTTINGS, AND CERTAIN PHYSIOLOGICAL PROPERTIES OF POPLAR CUTTINGS.] Folia for. polon. (Lesn.) No. 11, (121-68). [54 refs. [Pol.ru.g.].]
Investigations on Populus X robusta and P. X regenerata showed that terminal cuttings made good propagating material, giving a maximum take of 70% and good growth.

Zakhariev, B., Iliev, S., and Kolarov, D. 1972. [POSSIBILITIES OF IMPROVING THE PRODUCTION OF POPLAR PLANTING STOCK BY USING THE WINTER STEM CUTTINGS WITH GOOD PLANTING QUALITIES.] Gorskostopanska Nauka 9 (5): 41-53. [Bulg.ru.du., 19 ref.]

Zufa, L. 1966. [VEGETATIVE PROPAGATION OF HYBRID POPLARS OF THE SECTION LEUCE.] Topola, Beograd 10 (57/58): 2-8. [28 refs. [Serb.F.] 6 photos. 5 tbls.]

Zufa, L. 1971. A RAPID METHOD FOR VEGETATIVE PROPAGATION OF ASPENS AND THEIR HYBRIDS. For. Chron. 47 (1), (36-9). [E.fr., 9 refs.]
Large variations in sucker production occurred within and between species and hybrids.

232.4

Bani, A. 1970. [POPLAR GROWING ON SANDY SOILS DERIVED FROM THE EARLY DELTAS OF THE PO.] Monti e Boschi 21 (6): 21-32. [It.e.]
Describes the successful establishment of Poplar plantations on these soils in the lower parts of Ferrara and Rovigo provinces and discusses silvicultural, financial and marketing measures essential to their economic success.

Burg, J. van den. 1973. [FERTILIZATION AND MINERAL NUTRITION OF POPLAR ON YOUNG MARINE SOILS.] Internal Report nr. 39, Forest Research Station, Wageningen. [Du.]

Goor, C. P. van, Lynden, K. R. van, and Meiden, H. A. van der. 1969. [TREE SPECIES TO BE USED IN NEW AFORESTATIONS.] Koninklijke Nederlandsche Heide Maatschappij, Arnhem. [Du.]
This book deals with the possibilities offered a.o. by poplar for new plantations on the different soil types in the Netherlands.

Kohan, S. 1970. EXPERIENCE IN USING SAPLINGS OF VARIOUS AGE IN ESTABLISHING POPLAR STANDS IN EAST SLOVAKIA. Les (bratislava) 26 (8): 350-352. [Slo.]

Toth, K. 1969. EXPERIENCES WITH AGRICULTURAL POPLAR PULPWOOD PLANTING IN THE COMITAT BACS-KISKUN. Erdo 18 (2): 54-58. [Hu.]

232.41

Anonymous. 1967. SPECIFICATION FOR NURSERY STOCK. PART 5. POPLARS AND WILLOWS FOR TIMBER PRODUCTION. METRIC AND INCH UNITS. Brit. Stand. No. B.S. 3936: Part 5, pp. 10. [1 ref. Price 5s.]

Edwards. W. R. N. 1968. A NEW METHOD OF POPLAR POLE PROTECTION. Soil and Water 5 (2): 8.

Elzenga, G. 1971. [POPLAR INSPECTION BY THE NAKB [NETHERLANDS GENERAL INSPECTORATE FOR FOREST NURSERY PLANTS].] Populier 8 (5): 86-8. [NI]
Describes the procedures for inspection and certification of Poplar propagation material.

Ivkov, R. 1964. [THE STORING OF PLANTING STOCK IN WATER BEFORE PLANTING.] Sumarstvo 17 (3/4), (95-106). 8 refs. [Serb.e.]
Concludes that the use of water is necessary only when mean daily temperatures at transplanting time are > 7-8°C. and roots are active.

Jansen, E. S. 1974. [THE SPACING FOR ONE-YEAR POPLAR PLANTS TO MEET THE MINIMUM STANDARDS OF THE EEC AND THE MINIMUM REQUIREMENTS OF THE NAKB [NETHERLANDS GENERAL INSPECTORATE FOR FOREST NURSERY PLANTS].] Populier 11 (1) 13-14 [NI]
Differences between cultivars in response to spacing are briefly discussed.

Kolster, H. W. 1968. [TRENDS IN SALES OF POPLAR PLANTS.] Populier, Wageningen 5 (2), (22-7). [Du.]
Gives tables and graphs showing sales in the Netherlands in 1948-67. Discusses various possible causes of the decline in Poplar sales since 1960.

Kolstier, H. W. 1969. [POPLAR CLONES IN THE E.E.C. COUNTRIES.] Populier, Wageningen 6 (5), (80-2). [Du.]
Gives tables showing clones that may be planted, those that are undesirable, and clones whose import into the Netherlands should be forbidden.

Kolster, H. W. 1970. [EXPERIENCE WITH DIFFERENT TYPES OF POPLAR PLANTING STOCK IN DEMONSTRATION PLANTINGS BY THE STICHTING INDUSTRIE-HOUT.] Populier 7 (2), (19-27). [Du.]

Koster, R. 1969. [E.E.C. TRADE REGULATIONS FOR POPLAR PLANTS AND CUTTINGS.] Populier, Wageningen 6 (5), (74-5). [Du.]
Outlines existing and proposed regulations to ensure both the quality of the material and the suitability of the clones used.

Meiden, H. A. van der. 1964. [THE USE OF POPLAR SETS.] Populier 1 (3): 3-5. [Du.]

Papp, L. 1973. [THE STATE OF CONCENTRATED PRODUCTION OF POPLAR AND WILLOW PROPAGATING MATERIAL.] Erdo 22 (9): 410-412. [Hu.]

Roos, W. 1968. [THE PRODUCTION AND TREATMENT OF POPLAR CUTTINGS.] Populier 5 (4): 69. [Du.]

Sekawin, M. 1974. [APPROVED POPLAR CLONES IN ITALY.] Topola 18 (100/101): 17-19 [Sh.e.]
Gives notes on the 13 clones of Populus X euramericana [P. X canadensis] and P. deltoides approved for commercial use in Italy.

232.411

Scheffler, M. I. 1970. [TWENTY FIVE MILLION POPLAR PLANTS IN 20 YEARS.] Holzzucht 24 (4). (43-4). [G.]
Tabulates data on Poplar nurseries in W. Germany and Poplars raised in them in the years 1950/51-1969/70.

232.412

Edwards. W. R. N., and Robertson, A. G. 1971. WATER STATUS AND GROWTH INITIATION IN POPULUS. Thesis, Massey University, New Zealand 130 pp.

Marcet, E. 1974. VERSUCHE ZUR PFLANZUNG ENTASTETER PAPPELN. Holzzucht, Reinbeck 28, 3/4, 31-35, [6 Abb., 1 Tab., 5 Lit. Ang.]

232.42

Bowersox, T. W., and Ward, W. W. 1970. BLACK POLYETHYLENE MULCH AN ALTERNATIVE TO MECHANICAL

CULTIVATION FOR ESTABLISHING HYBRID POPLARS. Tree Plant. Notes 21 (1), (21-4). [6 refs.]
Results indicate that success in establishment when black polyethylene mulch is used can equal or exceed that of mechanical cultivation.

Horvath, L. 1964. [DEEP PLANTING OF FOREST PLANTS.] Erdo 13 (3), (97-101 + smries. in suppl.). [Hu.ru.g.]
Describes a deep ploughing method in which plants ca. 100 cm. high are set against an 80-cm. plough slice and covered by the next slice.

Markovic, J. 1964. [TECHNIQUES AND NORMS FOR WORK WITH A SPECIAL AUGER FOR DEEP PLANTING OF POPLARS IN SAND.] Topola, Beograd 8 (44), (25-7). 2 refs. [Serb.f.]
Presents data from trials with hand-operated augers of 11 and 20 cm. diam. making planting holes up to 3 m. deep.

Ostric, I. 1964. [THE USE OF EXPLOSIVES IN MODERN FORESTRY.] Sum. List 88 (1/2), (37-42). 2 refs. [Serb.e.]
Gives details of time, costs and quantities of explosive needed for blasting planting holes for Poplars.

Prevosto, M. 1971. [A NEW MACHINE FOR PLANTING POPLARS.] Cellulosa e Carta 22 (5), (47-55). [It.f.e.de.]
Describes and illustrates with photos, tests of the prototype of a French machine with which Poplars can be planted at depths of up to 3 m.

Prevosto, M. 1972. [USE OF NEW MACHINES FOR DEEP PLANTING OF POPLARS.] Cellulosa e Carta 23 (10) 3-15 [It.f.e.du., 7 ref.]
Gives results of large-scale comparative trials in Italy during 1971-72 on the economics of planting Poplars with the French Castelbajac drilling machine and the Italian Ellettari screw auger.

Roksandic, P. 1974. [DEEP PLANTING OF POPLARS ON SOILS OF THE DRAVA-DANUBE BASIN.] Sumarski List 98 (12) 521-528 [Sh.e]
Discusses the problem of boring deep planting holes (3 or 4 m deep) for Poplars on alluvial soils in Yugolsavia.

Singh, B., and Monappa, K. 1968. EFFECT OF DIFFERENT DEPTHS OF PLANTING AND MANURING ON THE GROWTH AND SURVIVAL OF POPLARS IN THE RAVINE LANDS–I. Indian Forester 94 (9): 675-681.

Singh, B., and Monappa, K. 1969. EFFECT OF DIFFERENT DEPTHS OF PLANTING AND MANURING ON THE GROWTH AND SURVIVAL OF POPLARS IN THE RAVINE LANDS–II (WATER BALANCE-CUM-GROWTH STUDIES). Indian Forester, 95 (8): 532-538.

Tircomnicu, C., and Rus, V. 1968. [MECHANIZATION OF PLANTING POPLAR CUTTINGS.] Rev. Padurilor 83 (8), (440-4). [Ro.]
Describes the Italian CIMA machine for planting cuttings.

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Briefly describes and illustrates trials of a special hydraulic soil auger for planting Poplar 'poles' in holes 3 m deep.

Vidali, E. 1973. [DEEP POLE PLANTING WITH TWO-YEAR-OLD POPLAR STOCK: A MODERN AND RATIONAL METHOD OF ACHIEVING BETTER GROWTH.] Cellulosa e Carta 24 (6): 53-60. [It.f.e.du., 8 ref.]
Describes and illustrates the method, by which 2-year-old Poplar 'poles' are planted 3 m deep in holes of 9 or 12 cm diameter made by an Elletari hydraulic auger.

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Anonymous. 1964. ROADSIDE PLANTATIONS. U. P. Forest Dept. Annual Research Report, Silviculture Sal Region-Nainital.

Adema, K. 1968. [AN EXPLOITATION SURVEY OF POPLAR PLANTATIONS.] Populier, Wageningen 5 (1), (4-6). [Du.]
Gives tables of expenditure, yields and profits of plantations.

Fakirov, V. 1972. [GROWTH AND YIELD OF HYBRID BLACK POPLAR PLANTATIONS PLANTED AT VARIOUS INITIAL DENSITIES ON DANUBE FLOOD-PLAIN SITES.] Gorskostopanska Nauka 9 (1): 37-52. [Bulg.ru.du., 9 ref.]

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Gunzl, L. 1972. POPLAR PLANTED AT LARGE SPACINGS ABOVE SPRUCE. Schweiz Pappel-arbeitsgemeinsch Mitt 21: 9-13. [F.]

Iliev, A., et al. 1966. [EFFECT OF DENSITY ON THE GROWTH AND PRODUCTIVITY OF POPLAR PLANTATIONS.] Nauc. Trud. Lesotch. Inst. Sofija 14, (41-8). [3 refs. [Bulg.ru.g.].]
Tabulates data on the growth of P. X 'canadensis' stands planted in the Danube basin in 1958 at spacings from 3 X 3 m. to 10 X 10 m.

Iliev, A., Bogdanov, B., et al. 1970 [GROWTH AND YIELD OF POPLAR PLANTATIONS AS A FUNCTION OF STAND DENSITY.] Gorsko Stopanstvo 26 (3): (10-7). [Bulg., 3 refs.]
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Marcu, G. 1966. [POPLAR PLANTING DENSITY.] Rev. Padurilor 81 (10), (547-52). [15 refs. [Ro.].]
Gives establishment costs for spacings 2 X 2 to 8 X 8 m., on a medium-quality soil.

Milovanovic, M. 1967. [SPACING IN PLANTATIONS AND POPLAR GROWTH.] Topola, Beograd 11 (61/64), (196-9). [Serb.f.] [3 tbls.]
Gives tables showing the mean height, d.b.h., volume per ha., and volume increment of Populus 'Robusta', 'Istarska', 'Marilandica' and 'Serotina' at 8 years, at spacings of 3 X 3 to 7 X 7 m.

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Tabulates form quotients for spacings of 1·5 X 1·5, 2 X 2, 3 X 3, and 4 X 4 m. and d.b.h. 8, 10 . . . 30 cm.

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Stern, R. C. 1972. POPULAR GROWING AT CLOSE SPACING. Timber Grower No. 44, 20-24 [E., Another version in Quarterly Journal of Forestry 66 (3) 230-235]
Profitability assessments indicate that growing at close spacing is reasonably profitable and that coppicing may be even more so.

Szodfridt, I. 1967. [THE ECONOMIC SPACING OF BLACK POPLAR HYBRIDS.] Erdo 16 (2): 82-4. [Hu.ru.g.]

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Discusses the economic merits of different spacings for Poplar plantations, and compares the growing conditions, spacings used and yields expected in Spain, Latin America and Italy.

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Gruneklee, H. G. 1965. [REVEGETATION OF WASTE-LAND IN THE RUHR CONURBATION.] Forst- u. Holzw. 20 (22), (504-10). 11 refs. [G.]

Guldemond, J. L. 1971. [PLANTING POPLAR ON REFUSE-DEPOSITS.] Populier 8 (2): 30-34. [Du.]

Gunz, L. 1971. [GUIDELINES FOR THE AFFORESTATION OF MARGINAL AGRICULTURAL SITES, WITH SPECIAL REFERENCE TO FAST-GROWING SPECIES.] Allg. Forstztg. 82 (10), (287-91). [De., 8 ref.]
Discusses chiefly combinations of species, spacing, establishment and tending, for marginal sites with a good nutrient status and water supply.

Hesmer, H., and Gunther, K. -H. 1966/1968. [PLANTING TRIALS AND EXPERIENCE WITH REFORESTATION ON THE PSENDOGLEY SITES OF THE KOTTENFORST [N.W. GERMANY]. I. HARDWOODS. II. CONIFERS.] Forstarchiv 37 (1), (1-26): 39 (1), (1-23). [G.]
Discusses results of reforestation trials dating mostly from the early 1950's, on a war-devastated plateau of 400 ha. near Bonn characterized by waterlogging and late frosts.

Lorio, P. L., Jr., Gatherum, G. E., and Shrader, W. D. 1964. TREE SURVIVAL AND GROWTH ON IOWA COAL-SPOIL MATERIALS. Spec. Rep. Ia. Agric. Exp. Sta. No. 39, pp. 12. 21 refs.
Presents measurements after 7-8 years of plantations of 10 conifer and 6 broadleaved species on several classes of coal spoil materials in S.E. Iowa.

Margus, M. 1973. [CHOICE OF TREE SPECIES FOR PROTECTIVE STANDS ON LEVELLED OPEN-CAST ROCK-PHOSPHATE WORKINGS.] Metsanduslikud Uurimused 10, 200-225. [Ee.ru.de., 19 ref.]
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Discusses slag/ash and pure ash heaps in Poland, and the results of recent afforestation trials.

Morawski, S. 1968. [RESULTS OF AFFORESTATION TRIALS ON WASTELAND AFTER ZINC AND LEAD MINING.] Sylwan 112 (2), (47-54). [5 refs. [Pol.ru.e.].]
Gives results of investigations of Polish plantings 7 and 10 years old, comprising > 20 tree and shrub species.

Moroz, P. I. 1972. ON THE ESTABLISHMENT OF POPULUS STANDS ON LIGHT-TEXTURED FRESH SOILS WITHOUT HAND CARE IN THE DNIEPROPETROVSK DISTRICT. Visnyk Sil's'kohospodar Nauk 5: 74-76. [Ukr.]

Pankov, Ya. V., Ivanov, F. E., and Andryushchenko, P. F. 1974. [POPLAR PLANTATIONS FOR THE REHABILITATION OF WASTELANDS IN THE KURSK MAGNETIC ANOMALY.] Lesnoi Zhurnal 17 (6): 21-23 [Ru., 1 ref.]
Concluded that Poplars are extremely promising for the rapid rehabilitation of these sites.

Petrukhnov, V. P. 1969. THE GROWTH OF POPULUS STANDS ON RECLAIMED LANDS OF THE UKRAINIAN POLES'E. Lesovod Agrolesomelior 18: 150-157. [Ru.]

Podzharov, V. K. 1974. [USE OF WORKED-OUT PEAT DEPOSITS FOR FORESTRY.] Lesokhozyaistvennoe osvoenie torfyanykh vyrabotok. Minsk, USSR; Uradzhai. 120 pp. [Ru., 119 ref., BLL.]
On the basis of research and experience mainly in Belorussia on areas left after large-scale peat harvesting, the author describes the

properties of bottom peats and residual peats in relation to their suitability for afforestation.

Poel, A. J. van der. 1968. [POPLAR AFFORESTATIONS IN THE NEW POLDER. OOSTELIJK FLEVOLAND.] Populier 5 (4): 64-66. [Du.]

Ranft, H. 1965. [FIRST STAGE OF REVEGETATION OF THE ERZGEBIRGE SPOIL MOUNDS.] Sozial. Forstw., Berl. 5 (8), (237-9, 242). [G.g.]
Pioneer or nurse species such as Alders or Robinia, and crop species, including Poplars and Aspen, have been planted. The use of containers and of larger-than-usual transplants improved survival.

Safar, J. 1968. [PROBLEMS OF AFFORESTATION IN THE LITTORAL KARST REGION [OF JUGOSLAVIA].] Sum. List 92 (3/4), (147-53). [Serb.e.]
Reviews the past history of afforestation in this region and recommends for the wetter soils adjacent to fresh or salt water, Populus spp.

Schlatzer, G. 1964. [SOME PROBLEMS OF PLANTING UNDER EXTREME CONDITIONS.] Dansk Skovforen. Tidsskr. 49 (3), (79-98). [Dan.e.e.]
Describes planting experiments in 1958-63 on two parts of a site strip-mined for lignite.

Tarcevskij, V. V., and Hamidulina, M. V. 1966. [AFFORESTATION OF SPOIL MOUNDS.] Lesn. Hoz. 19 (12), (28-9). [Ru.]
Reports trials in the Urals and Kuzbas regions on the establishment of trees and shrubs on ash spoil mounds (from power stations). Ball planting of Poplar is possible, even on pure ash.

Toth, B. 1965. [FORTY YEARS' RESEARCH RESULTS ON THE AFFORESTATION OF SZIK SOILS IN HUNGARY.] Ungarische Forstwissenschaftliche Rundschau, Budapest (107-17, 173-82). [G.Ru.]
Discusses the activities of the research institute for szik soils, including soil classification, ameliroation, species planted (with special reference to Poplars) etc.

Vis, T. 1970. [INVENTORY OF THE GROWTH OF SOME TREE SPECIES ON MARINE CLAYS AND SANDS IN ZEELAND.] Ned. Bosb. Tijdschr. 42 (1), (14-29). [Du.e., 9 refs.]
Results of a study of height growth of Populus 'Robusta' and P. 'Zeeland', on a number of plots with different soil textures are given in graphs with English legends and tables.

Werner, K. 1973. RECLAMATION OF LAND DAMAGED BY OPEN-CAST MINING – METHODS AND RESULTS. Biological Conservation 5 (4): 277-280 [E., 16 ref., OBD.]
A brief report on legislation and research and on the objects of reclamation and successes in the German Democratic Republic. Afforested sites have been stocked mainly with Populus spp.

Zastenskii, L. S. 1974. [GROWING FORESTS ON WORKED-OUT PEAT DEPOSITS.] Lesovyrashchivanie na vyrabotannykh torfyannikakh. Moscow, USSR; Lesnaya Promyshlennost'. 128 pp. [Ru., 28 ref., BLL.]
Particular attention is paid to the use of machinery in the establishment of plantations on these sites.

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235 UNDERPLANTING, ADVANCE PLANTING ETC. NURSES AND FORMATION OF MIXTURES. INTERPLANTING OF INFERIOR GROWTH

Lavezzini, A. 1971. LE CONSOCIAZIONI DEI PIOPPETI; CROPS INTERPLANTED IN POPLAR STANDS. Esso Agr. 2: 24-25 [It.]

Piotrowski, J. B. 1974. [USING POPLAR PLANTATIONS FOR THE PRODUCTION OF SPRUCE CHRISTMAS TREES.] Sylwan 118 (9): 39-49 [Pol.ru.e., 37 ref.]
Describes experience in several forest districts in SW Poland where Christmas trees (Picea abies) had been grown between the rows in Poplar plantations for the first 7 years.

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Leibundgut, Hans. 1969. PAPPELN ALS BAUMARTEN DES VORWALDES. Holzzucht, Reinbek 23, 1, 1-5. [6 Abb., 2 graph. Darst.]

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Brundl, L., and Tompa, K. 1969. [INTERPLANTING POPLARS WITH OSIER WILLOWS.] Erdo 18 (6): 269-73. [Hu.ru.g.] [2 figs. 2 tbls.]

Red Ko, G. I. 1966. [TRIAL OF POPLAR AS AN ASSOCIATE SPECIES IN OAK/PINE PLANTATIONS IN THE UKRAINE.] Lesn. Z., Arhangel sk 9 (6): 38-40 + 1 tbl. [Ru.]

236 CARE OF REGENERATION OR PLANTATIONS IN THE INITIAL STAGES OF ESTABLISHMENT

Beky, A., Gergacz, J., Halupa, L., and Kovacs, F. 1971. [CHEMICAL WEED CONTROL IN THE POPLAR STANDS OF THE HANSAG REGION.] Erdeszeti Kutatasok 67 (1): 189-202. [Hu., 17 ref.]
Reports trials of Dikonirt [2, 4-D] at 2-3 kg/ha with Sys 67 Omnidel [dalapon] at 5-40 kg/ha for the control of tall weeds and grasses in 4- and 7-year-old stands of hybrid Black Poplars.

Beky, A., Gergacz, J., Halupa, L., and Kovacs, F. 1974. [THE ECONOMIC EFFECTIVENESS OF CHEMICAL WEEDING IN POPLAR STANDS.] Erdo 23 (5): 229-233. [Hu.ru.e.]
The recommended treatment is 3 kg/ha Dikonirt (2, 4-D) + 10 kg/ha Sys 67 Omnidel applied twice in the first year and once in the second and fourth years.

Byrnes, W. R., and Merritt, C. 1966. RESPONSE OF PLANTED HARDWOOD SPECIES ON OLD-FIELD SITES TO WEED CONTROL. Abstr. Mtg. Weed Soc. Amer. (29-30). [From abstr. in Weed Abstr. 16 (5), (No. 1700). O. W.]
The response of Liriodendron tulipifera and Populus sp. to intensive culture, including chemical and mechanical weed control, was evaluated on bottomland sandy loam and upland silt loam.

Byrnes, W. R., and Murray, G. 1968. PLANTED HARDWOODS RESPOND TO WEED CONTROL ON BOTTOMLAND SITES. Abstr. in Proc. 23rd Nth. Cent. Weed Control Conf. (34-6). From abstr. in Weed Abstr. 1971 20 (2), (No. 716). OW.]
Simazine at 3·15 lb + aminotriazole at 1·05 lb/acre were applied annually for 2-3 years to control broadleaved weeds among 1- to 3-year-old rooted cuttings of Populus X eugenei planted on a sandy loam soil.

Cunningham, F. E., and Sowers, D. W., Jr. 1965. SIMAZINE NO SUBSTITUTE FOR CULTIVATION IN HYBRID POPLAR PLANTATIONS. Tree Plant. Notes No. 70, (21-6). 8 refs.

Garyphalos, I. 1971. PRIVATE POPLAR CULTIVATION IN GREECE AND ITS PROBLEMS. Dassika Chron. 13 (150): 16-25. [Fin.]

Gildemyn, H. 1966. [CHECK DUE TO ROTARY CULTIVATION IN A YOUNG POPLAR PLANTATION ON A MOIST SOIL.] Bull. Soc. For. Belg. 73 (2), (89-99 + 1 plate). 8 refs. [F.]
Contrary to general experience elsewhere, cultivation apparently had no effect on increment.

Hoffmann, G. 1965. [PHYSIOLOGICAL STUDIES ON PLANTS AS A BASIS FOR DETERMINING THE BEST TIMES FOR TENDING IN PLANTATIONS.] Sozial. Forstw., Berl. 15 (10), (294-9 + smries.). 14 refs. [G.ru.e.]
Discusses the effect of shading and root competition by weeds, and presents a preliminary E. German timetable of preferred and permissible dates for mechanical weeding in spring.

Kazantsev, I. IA. 1971. CULTURE OF POPLAR VARIETIES UNDER CONDITIONS OF VOLGA-AKHTUBA FLOOD PLAIN. Les. Khoz 12: 29-31. [Ru.]

Krinard, R. M. 1964. CULTIVATION STILL BEST METHOD OF WEED CONTROL IN DELTA COTTONWOOD PLANTATIONS. Mississippi Farm Research, State College, Miss. 27 (5): (8). C.G.B.
Six chemical treatments were tried, but none controlled the weeds (chiefly Johnson grass) beyond May, and results were poor.

Kurdi, I. 1972. [THE CONTROL OF AGROPYRON REPENS.] Erdo 21 (4): 154-159. [Hu.ru.e.]
In a trial plot of hybrid Poplar regularly tended by spraying with Lys 67 Omnidel (dalapon), the volume c.a.i. at 12 years of age was 1.7 times that of an adjacent untended plot infested with A. repens.

Muller, R., and Schmidt, G. 1964. [USE OF HERBICIDES IN POPLAR PLANTING.] Sozial. Forstw., Berl. 14 (5): (151-2). [G.] *Shows the savings in DM./ha. made by chemical weeding 6-year Populus x berolinensis and 4- and 5-year P. x marilandica and P. x egenerata.*

Ujvari, F. 1969. [THE EFFECT OF CHEMICAL WEED CONTROL ON THE GROWTH OF A POPLAR STAND.] Erdo 18 (1), (31-3). [Hu.ru.g.]

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Kolster, H. W. 1969. [PLASTIC SHEETING IN WEED CONTROL IN POPLAR PLANTATIONS.] Populier, Wageningen 6 (2): 25-31. Du.] [5 sets of figs. 12 tbls.]

Guldemond, J. L., and Oldenkamp, L. 1967. [CONTROL OF COPPICE IN POPLAR PLANTATIONS.] Populier 4 (2): 32-33. Du.]

237 AMELIORATION OF FOREST SITES

Anonymous. 1965. [PROCEEDINGS, 5TH WORLD FERTILIZER CONGRESS, ZURICH 1964.] Centre International des Engrais Chimiques (CIEC). pp. ca. 400. Many refs. [G.F. or It.] H.S.B.

Anonymous. 1965. [FERTILIZERS IN FORESTRY.] Allg. Forstzeitschr. 20 (16/17), (241-64). 26 refs. [G.]

Borsdorf, W. 1965. [THE EFFECT OF MINERAL FERTILIZERS ON GROWTH AND OVEN-DRY DENSITY OF YOUNG POPLARS.] Arch. Forstw. 14 (1), (61-78). 33 refs. [G.g.ru.e.]
Describes trials from cuttings on a poor sandy soil fertilized with NPK at respectively 5, 10 and 15 g./sq.m.

Charlon, J., and Gouere, A. 1969. [FOREST FERTILIZING AND BASIC SLAG.] S.N.S.T. [Societe Nationale de la Scorie Thomas], Paris. [[F.] From review in C.R., Acad. Agric. France 55 (8), (613-4). [F.] A.P.B.]
A booklet giving the results of fertilizer experiments.

Czerney, P., and Fiedler, H. J. 1969. [POT TRIALS WITH WERMSDORF SILTY LOAM ON THE EFFECT OF FERTILIZERS ON SOME CONIFERS AND HARDWOODS.] Arch. Forstw. 18 (2), (133-53). [8 refs. [G.g.ru.e.].]
Poplar responded best to balanced fertilizing.

Decollogny, P. 1965. [AN UNUSUAL FILTERING STATION FOR EFFLUENTS.] Foret, Neuchatel 19 (1), (7-10). [F.] 4 photos.
A Swiss mountain village conducted its domestic effluents to a coppice forest. Planted poplars grew very well and produced a thick layer of humus of excellent filtering capacity.

Dragun, W. 1964. [IRRIGATING POPLAR PLANTATIONS WITH SEWAGE EFFLUENTS.] Zeszyty Problemowe Postepow Nauk Rolniezych, Warszawa No. 47, (169-81). 3 refs. [Pol.pol.ru.g.ru.g.] H.S.B.
A 'Robusta' plantation irrigated with purified town effluent at 1700-1800 mm./year, exceeded an unirrigated control in leaf size, vigour, length of growing period and increment in height and diam.

Ganchev, A., and Ganchev, P. 1971. [SOIL MOISTURE, GROWTH, AND DEVELOPMENT OF SOME POPLARS.] Gorsko Stopanstvo 27 (10), (3-7). [Bulg.]
Tabulates data on the monthly height and diameter growth of 12 species and clones of Poplar in plantations in Bulgaria, with and without irrigation.

Hubener, E. 1973. [WASTE WATER DISPOSAL AREAS IN FORESTS: A CONTRIBUTION TO SAFEGUARDING THE ENVIRONMENT.] Sozialistische Forstwirtschaft 23 (7): 210-211, 220 [De., 2 ref.]
A general account describing the advantages of forest land for this purpose and the choice of the site and species.

Ivannikov, S. P., and Isarev, A. P. 1971. [POSSIBILITIES OF GROWING POPLARS WITH WASTE WATER IRRIGATION.] Lesn. Khoz. (1), (39-45). [Ru.]

Junack, H. 1966. [RESULTS OF FERTILIZER TRIALS IN YOUNG PLANTATIONS BY THE FORSTLICHE VERSUCHSRING NIEDERSACHSEN [FORESTRY RESEARCH GROUP, LOWER SAXONY].] Aus dem Walde, Hannover No. 11, pp. 188 + 10 photos. [10 refs., [G.g.].]
Methods of evaluation and effects on survival and stand structure are discussed.

Leroy, P. 1969. [FERTILIZER TREATMENT OF POPLAR: PRESENT KNOWLEDGE AND DIFFICULTIES OF ITS APPLICATION.] Rev. for. franc. 21 (3), (163-82 + smries.) [26 refs., [F.f.e.g.span.].]
An attempt to summarize present knowledge on the nutrition and growth of Poplars in France. Different types of Poplar site are described, the problems of nutrition that they present are considered, and the nutritional requirements and rooting habits of Poplars are discussed. The results of fertilizer trials on Poplars in various European countries are reviewed, and problems of competition by herbaceous species and of the relationship between fertilizer applications, frost-cracks and resistance of Poplars to fungi are examined. Fertilizer treatments in nurseries and plantations to improve growth and yield without heavy expenditure are proposed. It is admitted, however, that fertilizer technique in Poplar-growing is still imperfect.

Meiden, H. A. van der. 1964. [APPLICATION OF K FERTILIZERS TO POPLAR.] Kali, Amsterdam 6 (59), (295-301 + 4 photos). [Du.] P.O.
Leaf and soil analyses showed K deficiencies on many of the main Poplar sites of the Netherlands.

Meiden, H. A. van der. 1964/1965. [FERTILIZATION OF POPLAR WITH K.] Foret privee, Paris No. 40, (123-7); 41, (109-212). [F.]
Summarizes the results of foliage and soil analyses in 17 Poplar plantations in different parts of the Netherlands.

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Taris, B. 1966. PEUPLIERS ET POPULICULTURE. [POPLARS AND POPLAR GROWING.] Editions Eyrolles, Paris. pp. xvi + 207. [137 refs.] [F.]
A practical manual, covering: systematics; propagation; establishment and tending; biotic and abiotic causes of injuries; utilization; economics; and state assistance.

Tihanyi, Z. 1970. [THE CHIEF FACTORS AFFECTING POPLAR-GROWING ON MARSHY SOILS IN THE NAGYBEREK [NEAR LAKE BALATON].] Erdo 19 (1): 11-5. [Hu.ru.e.]
Trial plantings near Lake Balaton showed that Poplars may be grown on highly calcareous peaty soils if soil depth and groundwater levels are suitable.

Viart, M. 1972. [THE PRESENT STATE OF, AND TRENDS IN, POPLAR GROWING IN FRANCE.] Revue Forestiere Francaise 24 (2): 83-97. [F.e.es.de.]
A review based on two reports by the French National Poplar Commission to the XIVth Session of the [FAO] International Poplar Commission, Rumania, 1971.

Vivani, W., and Rota, L. 1968. PRESENT PROBLEMS OF POPLAR GROWING IN ITALY. Unasylva 22 (4): 16-9. [3 figs. 1 tbl.]
Discusses the economic and technical crises affecting Poplar growing in Italy. Wider spacing, longer rotations and association of tree growing with traditional farm crops are suggested.

Weisgerber, H. 1964. DIE WALDBAULICHE BEDEUTUNG DER PAPPELSEKTION LEUCE. Forst- u.Holzwirt, Hann. 19 (12): 272-276. [1 Abb., 1 Tab., Lit. Ang.]

24 TENDING OF STANDS AND TREES

Chmielewski, W. 1970. POPLAR CULTIVATION IN PLANTATIONS. Sylwan 114 (8/9): 189-192. [Pol.]

Dimitrijevic, Z. 1970. STATE ON THE WORK ON THE ESTABLISHMENT OF POPLAR PLANTATION AND OTHER POPLAR AND WILLOW CULTURES IN 1969 IN YUGOSLAVIA. Topola 14 (79/80): 69-70. [Croat.]

242 THINNINGS

Fakirov, V. 1965. [RESULTS OF TENDING FELLINGS [THINNINGS] IN MIDDLE-AGED POPLAR STANDS.] Gorskostop. Nauka, Sofija 2 (5): 363-74. [7 refs. [Bulg.ru.g.].]

Fakirov, V. 1965. [THINNINGS IN MIDDLE-AGED POPLAR STANDS.] Gorsko Stopanstvo 21 (3): 4-6. [Bulg.]
Thinning trials in plantations aged 10-20 years, spaced 1·5 X 1·5 to 3 X 3 m.

Fakirov, V. 1966. [EFFECT OF THINNINGS ON INCREMENT BY GROWTH CLASSES IN MIDDLE-AGED POPLAR STANDS.] Gorskostop. Nauka, Sofija 3 (3): 203-12. [4 refs. [Bulg.ru.g.] 4 gphs. 2 tbls.]

Fakirov, V. 1968. [CHANGES IN CANOPY CLOSURE IN THINNED AND UNTHINNED POPLAR STANDS.] Gorskostop. Nauka, Sofija 5 (3): 53-63 + 4 plates. [5 refs. [Bulg.ru.g.].]

Fakirov, V. 1968. [THE START AND INTENSITY OF THINNINGS IN YOUNG POPLAR PLANTATIONS ON FLOOD-PLAIN SITES BY THE DANUBE.] Gorskostop, Nauka, Sofija 5 (2): 3-13. [18 refs. [Bulg.ru.g.].]
Bulgarian plantations of Populus X regenerata established at 2·5 X 2·5 m. were first thinned at age 4 or at age 6 by removing 25 or 50% of the trees. The 25% thinning was best at age 4, but 25 or 50% thinning was possible at age 6.

Fischer, F. 1974. RESULTS OF A TOP THINNING TEST IN A POPLAR PLANTATION AGED ABOUT 30 YEARS NEAR UTZENSTROF. Mitt Schweiz Pappel Arbeitsgem 24: 1-3. [F.]

Halupa, L. 1972. [METHODS OF POPLAR GROWING AND [THEIR INFLUENCE ON] UTILIZABLE ASSORTMENTS.] Kiserletugyi Kozlemenyck Erdogazdasag es Faipar, D 63 (1/3): 17-28 [Hu.] From Hungarian Agricultural Review 22, 700. CGB.
Proposes that the best time to make the first thinning in stands planted [in Hungary] at spacings between 2 X 2 and 3 X 3 m is after the trees reach a mean d.b.h. of 10 cm.

Hubener, E., and Hieronymus, H. 1968. [THINNING PROBLEMS IN E. GERMAN POPLAR PLANTATIONS.] Sozial. Forstw., Berl. 18 (6), (177-81 + smries.). [G.g.e.ru.]
Includes recommendations for the timing and intensity of cleaning and thinning of stands or line plantings.

Stoiculescu, C. D. 1973. [RESULTS OF THE FIRST THINNING TRIALS IN SINGLE-CLONE STANDS OF HYBRID BLACK POPLAR.] Revista Padurilor 88 (2): 81-89 + smries. [Ro.ru.e.de.f., 9 ref.]
Reports the increment and yield of young plantations of Populus 'Robusta R-16' in two areas of SW Rumania, planted respectively at spacings of 2 X 2 and 4 X 4 m.

Szoderidt, I., and Palotas, F. 1968. [THINNING INTENSITY IN HYBRID BLACK POPLAR STANDS IN THE DANUBE FLOOD-PLAIN.] Erdesz. Kutatas., Budapest 64 (1/3): 93-102. [Hu.hu.ru.g.]

Toth, B. 1968. SOME CONCLUSIONS FROM THINNING EXPERIMENTS WITH GIANT POPLARS [POPULUS X ROBUSTA], AT NAGYHEGYES. Hung. For. sci. Rev. (70-6). [E.]
Describes a study in dense 6-year stands on meadow chernozem; the author concludes that 1 or 2 heavy thinnings are preferable to 3 moderate thinnings.

Vojtus, M. 1966. [SOME RESULTS FROM STUDIES ON THE TENDING OF POPLAR STANDS.] Ved. Prace Vyskum. Ust. Lesn. Hosp., Zvolen No. 7, (179-97). [22 refs. [Slovak.slovak.ru.g.].]
Discusses detailed growth data for Populus 'Marilandica' and P. 'Robusta' from thinning trials in Slovakia. Results confirmed the advantages of frequent thinnings of medium intensity.

243 OPENING OF THE CANOPY (INCREMENT FELLINGS, OVERHEAD RELEASE AND IMPROVEMENT FELLINGS)

Harrison-Smith, J. L. 1965. THE POISONING OF UNWANTED TREES. Farm For., Wellington 7 (3): 67-80.

MacConnell, W. P. 1962. HERBICIDE TESTS WITH SHOULDER-MOUNTED MIST BLOWERS. Proc. 16th Ntheast. Weed Control Conf. (408-16). From abstr. in Weed Abstr. 13 (2), 1964 (437). O.W.

245 TENDING OF TREES

Anonymous. 1964. [PRUNING ROADSIDE TREES, ESPECIALLY POPLARS.] Uitvoer. Versl. Bosbouwproefsta., Wageningen 6 (1), pp. 47. 2 refs. [Du.e.f.g.e.]
Information is given on the effect of pruning date and type of tool on healing, the effect of time of removing epicormics on the formation of new ones, and the effect of extent of pruning on increment and the formation of epicormics.

Borsdorf, W. 1966. [THE BEST TIME FOR PRUNING POPLARS.] Arch. Forstw. 15 (2): 153-67. 43 refs. [G.g.ru.e.]
April to mid-May appeared to be the best pruning season for quick healing in S.E. Germany. Aspects of fungus-infection or insect-infestation hazards and availability of labour are discussed.

Crofts, R. R. 1968. A SEMI-MECHANICAL METHOD OF HIGH PRUNING POPLAR. Quart. J. For. 62 (3): 207-13.
Describes equipment developed for pruning Poplar to a height of 30 ft. It consists of a tractor with a hydraulic platform and a compressor.

Deveaux, C. 1969. [THEORETICAL CONSIDERATIONS REGARDING PRUNING OF POPLAR.] Rev. for. franc. 21 (4): 281-4. [1 ref. [F.].]
A discussion of the evidence for regarding pruning as favourable rather than detrimental to diameter increment in Poplar stands.

Floricica, N. 1966. [ARTIFICIAL PRUNING OF EURAMERICAN POPLAR PLANTATIONS IN THE BUCHAREST REGION.] Rev.

Padurilor 81 (2), (67-70 + smries.). [Rum.f.g.]
Gives the results of a study made in dense plantations which demonstrates the effect on wood quality of postponement of pruning.

Harris, R. W. 1971. THE CONTROL OF TRUNK SPROUTS ON LANDSCAPE TREES. In Proceedings, 46th International Shade Tree Conference, Rochester, New York 1970, 57a-63a [E., 5 ref.] From Horticultural Abstracts (1972) 42, 1853.
In spraying trials, both NAA and 2,4,5-T effectively reduced the % of new epicormics on all the trees treated, whether they were dormant or had begun new growth.

Jobling, J. 1964. POPLARS: PRUNING. Extr. from Rep. For. Res. For. Comm., Lond. 1962/63, (43-4).
Vernier bands were fixed to 5-year-old Populus X robusta pruned to (a) 1/4, (b) 1/2, and (c) 3/4 of total height. Height growth was greatest and epicormics were fewest in (a).

Kosourov, Ju. F., and Ignatenko, V. K. 1966. [A V-SHAPED CUTTING BLADE FOR PRUNING STANDING TREES.] Lesn. Hoz. 19 (1): 78-9. [Ru.]
Describes and illustrates a V-shaped steel blade which is attached to a long pole and used for pruning Aspen and Poplar to a height of 6-7 m.

Leontovyc, R., and Gemfrsky, V. 1964. [DECAY OF POPLARS AFTER PRUNING.] Lesn. Cas., Praha 10 (9): 811-8. 5 refs. [Slovak.slovak.ru.e.f.]
In a study on Poplars of the section Aigeiros, it was found that pruning technique affected decay incidence only in relation to the speed of wound occlusion.

Pagony, H. 1967. [PRUNING OF POPLARS WITH SPECIAL REFERENCE TO THE FORMATION OF FALSE HEART AND FUNGAL INFECTION.] Erdesz. Kutatas., Budapest 63 (1/3): 271-81. [18 refs. [Hu.hu.ru.g.].]
Recommends pruning close to the stem in March or April, preferably before the branch base exceeds 4 cm. in diam.

Pagony, H. 1967. [STUDIES ON THE PRUNING OF POPLARS AND ITS EFFECT ON THE SOUNDNESS OF THEIR STEMS.] Proc. 14th Congr. Int. Union For. Res. Organ., Munich 1967 Pt. IV, Sect. 23, (494-6). [G.]
A note on the danger of infection of pruning wounds.

Pagony, H. 1968. THE PROBLEM OF TRIMMING POPLAR WITH SPECIAL REGARD TO PSEUDO-DURAMEN FORMATION AND FUNGUS INFECTION. Hung. For. sci. Rev. (52-63). [E.]

Pratt, E. R. 1964. POPLAR PRUNING. Quart. J. For. 58 (1): 70-3.
Notes on Poplar pruning, with particular reference to the production of wood for match stock. As a general rule, Poplars should be pruned up to half their height and never less than 16 ft.

Sachsse, H. 1966. INVESTIGATIONS OF THE INFLUENCE OF PRUNING ON THE FORMATION OF COLOURED HEARTWOOD AND TENSION WOOD IN SOME POPLAR SPECIES. Transl. Commonw. Sci. Industr. Res. Organ. Aust. No. 7929, pp. 16, [31 refs. Transl. by M. Godfrey from Holz Roh- u. Werkstoff 1965 23 (11), (425-34).]

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Anonymous. 1972. MEHR ASTREINES PAPPELSTAMMHOLZ FUR DIE HOLZINDUSTRIE. WIE ERZIEHT MAN EINEN WERTVOLLEN PAPPELSTAMM. Holz-Zentralbl., Stuttg. 98, (65/66) S.952, [2 Abb.]

Bol, M., and Guldemond, J. L. 1972. [PRUNING OF POPLARS IN ROADSIDE PLANTINGS IN THE NETHERLANDS.] Populier 9 (2): 35-37. [Nl., 4 ref.]
Discusses various aspects of pruning roadside Poplars, and gives information on growth after pruning and on various methods of pruning.

Hattem, D. van. 1964. [PRUNING METHODS AND PRUNING TOOLS.] Populier 1 (2): 6-8.

Hattem, D. van, and Spaarkogel, G. N. 1967. [PRUNING OF EPICORMIC SHOOTS.] Populier 4 (2): 29-31.

Meiden, H. A. van der. 1964. [PRUNING POPLARS.] Populier 1 (1): 4-6.

245.13

Borsdorf, W. 1965. [PRUNING BLACK POPLAR HYBRIDS.] Sozial. Forstw., Berl. 15 (6): 180-2. 7 refs. [G.] 4 photos. 1 gph.
Practical advice on timing, intervals, extent, tools, etc.

Milewski, J. 1967. [GRAFTING WAX ACCELERATES THE OCCLUSION OF PRUNING WOUNDS IN POPLAR.] Las polski 41 (7): 15. [Pol.] [2 photos. 1 tbl.]
Describes the effect of grafting wax in promoting wound occlusion in Populux X marilandica.

26 COMBINATIONS OF FORESTRY WITH AGRICULTU

261 ALTERNATE FORESTRY AND AGRICULTURE, PERIODIC OR TEMPORARY AGRICULTURAL USE OF FOREST LAND

Bakker, A. 1966. [POPLAR GROWING AND GRASSLAND.] Populier 3 (3): 38-40. [Du.]
Deals with the influence of poplar line plantations on the botanical composition and the yield of adjacent grassland.

262 FUEL AND FODDER FORESTS

Adeleye, I. O. A., and Kitts, W. D. 1974. THE EFFECT OF NITROGEN SOURCE OF THE IN VITRO CELLULOSE DIGESTION OF CHEMICALLY TREATED OAT STRAW AND POPLAR WOOD. J. Agric. Sci. (Camb) 82 (3): 571-573.

Radkov, D. P. 1964. [DETERMINING THE TIME FOR LOPPING FOLIAGE FOR FODDER FROM THE COMMONEST BULGARIAN TREE SPECIES IN RELATION TO CHANGES IN THE CHEMICAL COMPOSITION OF THE LEAVES.] Gorskostop. Nauka, Sofija 1 (3): 23-8. 7 refs. [Bulg.ru.f.]
Tabulated data on the nutrient contents of leaves of Populus X 'canadensis' from 10 July to 30 Sept. show July to be the best month for lopping, as the leaves then had their highest content of crude protein.

Robertson, J. A., Beacom, S. E., and Shiels, R. 1971. FEEDING VALUE OF POPLAR SILAGE IN RATIONS FOR YEARLING STEERS. Can. J. Anim. Sci. 51 (1): 243-246.

263 IRRIGATED FOREST

Csikos Toth, I. 1966. [TWO-YEAR RESULTS OF GROWING BLACK POPLAR HYBRIDS WITH THE AID OF IRRIGATION.] Erdo 15 (8): 358-62. [Hu.ru.g.] [1 photo. 1 dgm. 2 tbls.]
Poplar planted at 2 X 2.5 m. spacing on pasture land reached heights up to 530 cm. and diams. up to 7.2 cm. Potential yields exceed those of agricultural crops.

Decei, I. 1971. [YIELD, PRODUCTIVITY AND ADAPTABILITY OF STANDS OF SALIX ALBA IN THE DANUBE FLOOD PLAIN.] In [Proceedings,] Working Group: The mensuration of the forest biomass and its productivity, IUFRO Section 25 [15th IUFRO Congress, Gainesville, Fla. 1971]. 8 pp. [F., 2 ref.]
On first-class sites, total volume growth of Willows exceeded that of hybrid Poplars and all other species grown. The growth of both Willow and Poplar plantations was closely related to the length and/or depth of flooding.

Gajic, M. R. 1968. [THE SIGNIFICANCE OF THE GROUND FLORA COMMUNITIES AND THE BELTS OF POPLAR AND WILLOW IN PROTECTING EMBANKMENTS ON THE LEFT BANK OF THE RIVER SAVA AT SREMSKA MITROVICA.] Sumarstvo 21 (7/8): 17-24. [6 refs. [Serb.g.].]
The distance of the protective belts of Poplar and Willow from the embankment must be taken into account, since the spread of L. perenne is favoured by shade.

Ionescu, A., et al. 1968. [SITE STUDIES ON THE GROWING OF EUROAMERICAN POPLARS IN THE DANUBE FLOOD-PLAIN.] Institutul de Cercetari Forestiere, Bucharest. pp. 123. [126 refs [Rum.f.e.].]
The principal factors affecting increment and yield are depth and duration of flooding, rate of flow of flood water, soil moisture, soil texture, and degree of gleying.

Paul, R. N. 1965. AFFORESTATION IN THE COLD DESERT OF INDIA. Indian For. 91 (1): 2-9 + 6 photos. 6 refs.
Describes the need of afforestation to meet the great scarcity of fuel, and the plantations of Willow and Poplar established during the last 50 years.

Radu, S., et al. 1968. [GROWING POPLARS AND WILLOWS IN THE DAM-BANK ZONE [OF THE DANUBE].] Centrul de Documentare Tehnica pentru Economia Forestiera, Ministerul Economici Forestiere, Bucharest. pp. 144. [136 refs. [Ro.f.e.f.e.].]
Discussion of the flood resistance of Populus alba, P. nigra, and hybrid Black Poplars.

Sircomnicu, C., and Radoi, D. 1969. [THE MECHANIZATION OF POPLAR GROWING WITH FAST-GROWING POPLARS IN THE DAM-BANK ZONE. THE TECHNIQUE AND EQUIPMENT FOR THE MAINTENANCE OF SUCH PLANTATIONS, AS PRACTISED ON THE CHISELET EXPERIMENTAL BLOCK.] Stud. Cerc. Inst. Cerc. For., Bucuresti 27 (3): 79-106. [Ro.ru.g., 8 refs.]

Tronco, G. 1967. [POPLAR CULTIVATION AND CATTLE RAISING ON RIVERAIN LAND [IN ITALY].] Ital. Agric. 104 (Aug): 808-21. [It.] [20 photos.]
Possibilities of using seasonally flooded riverside land for a profitable combination of Poplar growing and cattle raising.

264 FARM FORESTS

May, J. C. 1969. SOME USES FOR TIMBER, AND A CASE HISTORY OF TREE FARMING. Papers to Private Tree Farming Seminar, Univ. New England, Armidale, Dept. of Univ. Extn.

265 STRIPS OR LINES AT ROAD, RAIL AND CANAL SIDES, ETC.; HEDGEROW TREES

Bara, I. I., and Gheorghita, G. I. 1971. [EXPERIMENTAL PLANTING OF SOME SALIX AND POPULUS SPECIES IN THE ZONE PERIODICALLY FLOODED BY LAKE BICAZ.] Rev. Padurilor 86 (6): 293-4. [Ro., 2 ref.]
Greater than 50% of wildings of Salix sp. survived submergence of ca. 3 months soon after spring planting, but those of Populus sp. survived only where partly above water level.

Bura, D. 1970. [EFFECT OF POPLARS AND WILLOWS PLANTED NEAR RETAINING DAMS ON THE SAFETY OF THE DAMS.] Topola (81/82): 18-20. [Sh.e.]
Willows should not be planted nearer than 10 m or Poplars nearer than 30 m to the foot of earth dams and dikes.

Castellani, E., and Prevosto, M. 1967. INVESTIGATION ON THE NEGATIVE EFFECTS OF POPLAR ROWS ON SOME AGRICULTURAL CROPS. Proc. 14th Congr. Int. Union For. Res. Organ., Munich 1967 Pt. I, Sect. 11, (203-14). [1 ref. [E.e.f.g.].]

Eisenreich, H. 1971. [SOME FACTS ABOUT POPLAR GROWING.] Sozial. Forstw. 21 (3): 84-7, 94. [De. 2 ref.]
Discusses experience in the planting and tending of Poplars in rows along roads and watercourses in E. Germany.

Evrard, R. 1968. [GROWING POPLAR IN ROWS.] Ann. Gembl. 74 (2): 115-36. [8 refs. [F.] A.P.B.]
A general exposition of the lay-out, spacing, tending, etc. of row plantings of Poplars, with particular reference to the orientation of the rows.

Floricica, N., and Nedea, P. 1971. [THE SPECIAL PROTECTION AND PRODUCTION FORESTS OF THE DAM-BANK ZONE OF THE DANUBE AND ITS ISLANDS IN THE HFOV INSPECTORATE.] Rev. Padurilor 86 (8): 396-9 + smries. [Ro.e.f.ru.]
An account of the problems of establishing and managing forests along the artificial embankments in this part of Rumania.

Ghiorgita, G. I., Bara, I. I., and Misaha, C. G. 1972. [THE PERFORMANCE OF SOME SPECIES OF SALIX AND POPULUS UNDER CONDITIONS OF PERIODIC FLOODING ON THE BANKS OF LAKE BICAZ.] Revista Padurilor 87 (6): 294-298. [Ro., 2 ref.]

Kohan, S. 1966. [SOME RESULTS AND PROBLEMS OF ESTABLISHING LINE PLANTATIONS OF POPLARS ON THE E. SLOVAKIAN PLAIN.] Les. Bratislava 22 (2): 60-4. [6 refs. [Slovak.].]
Presents data on the growth and development of young 1-, 2- and 3-row plantings along canal and river banks.

May, S. 1971. REPORT TO THE GOVERNMENT OF PAKISTAN ON INTENSIVE FORESTRY WITH FAST-GROWING SPECIES IN WEST PAKISTAN. United Nations Development Programme, FAO, Rome. FAO Report No. TA 3012, pp. 80. [E., 10 ref.]
A report dealing mainly with the planting of Poplars and Eucalypts in irrigated plantations.

Polosina, M. I. 1973. [THE WATER REGIME AND BIOLOGICAL DRAINAGE ROLE OF WOODY PLANTS IN CANAL-SIDE STANDS IN THE LOWLANDS W. OF THE CASPIAN.] Lesovedenie No. 6, 60-68. [Ru.e., 9 ref.]
Presents data on the transpiration rates in June, July and Aug, of Populus X berolinensis, planted along a canal. The high expenditure of water in transpiration was very effective in lowering the water table.

Prevosto, M. 1971. [SOME ASPECTS OF POPLAR GROWING ALONG FIELD BORDERS.] Cellulosa e Carta 22 (6): 23-44. [It.f.e.de., 17 ref.]
Describes the correct siting, spacing and management of rows of Poplar along the edges of fields etc., and discusses their importance.

Sabau, V. 1967. [FOREST BELTS FOR THE PROTECTION OF FLOOD-PLAIN EMBANKMENTS.] Rev. Padurilor 82 (11): 573-7. [6 refs. [Ro.ru.e.g.f.].]
Populus nigra and P. X euramericana, can endure 50 days of flooding in the growing season and need not less than 60 cm. of aerated soil during the rest of the year.

Zundel, R. 1972. [POPLAR GROWING AND THE CARE OF THE COUNTRYSIDE.] Holzzucht 26 (3/4): 34-38 [De.]
Discusses experience with Poplars of different kinds, planted, alone or in mixture, mainly or exclusively for purposes other than wood production.

266 SHELTERBELTS, WINDBREAKS

Becher, R. 1968. WINDSCHUTZ MIT PAPPELN IN KUSTENNAHE. Holzzucht, Reinbek 22 (3): S.30, [2 Abb.]

Elamami, S., and Baldy, C. 1967. [PROVISIONAL RECOMMENDATIONS ON THE PLANTING OF WINDBREAKS IN THE IRRIGATED AREAS OF TUNISIA.] Documents Techniques, Institut National des Recherches Agronomiques de Tunisie, Ariana No. 28, pp. 15. [[Fr.arab.] A.P.B.]
Tamarisk is recommended for saline soils and Poplars for the cooler regions. Recommended planting densities, irrigation regimes, fertilizer treatment and orientations are shown.

Fedorenko, V. P. 1967. [EFFECT OF SHELTERBELTS ON THE ACCUMULATION OF HUMUS IN THE CHESTNUT SOILS OF THE ALTAI REGION.] Procoved. (11): 82-5. [10 refs. [Ru.e.] N.L.L.]
A report on studies of soils under, and 20-200 m. to leeward and to windward of, a 28-year Maple/Birch/Poplar/Willow shelterbelt in this dry steppe region.

Gal, J. 1967. [RESEARCH RESULTS ON SHELTERBELTS IN HUNGARY.] Erdesz. Faipari Egyetem Kiad., Sopron (2), pp. 83. [Hu.ru.g.ru.g.]
Sums up experience and research findings of 15 years' intensive shelterbelt planting.

Isaeva, T. L. 1973. [GROWTH OF WOODY SPECIES IN SHELTERBELTS IN THE KRASNODAR REGION.] Lesnoe Khozyaistvo No. 7, 40-43. [Ru.]
Gives data on the height increment of 8 species of broadleaved trees for various ages up to 23 years.

Joachim, H. F., and Grunert, F. 1974. [GROWING TREES OUTSIDE THE FOREST AS AN INTEGRAL PART OF AGRICULTURAL AMELIORATION SCHEMES: THE EXAMPLE OF THE BOLZINE AMELIORATION DISTRICT ON THE MIDDLE ODER.] Beitrage fur die Forstwirtschaft 8 (4): 197-203. [De.ru.e., 8 ref.]
Describes plans for systemic planting of rows and shelterbelts of trees and shrubs together with the draining and enlarging of fields. Suitable species are listed, Populus trichocarpa and other varieties of Poplars being the principal species.

King, E. 1970. [ECOLOGICAL AND METEOROLOGICAL STUDIES ON SHELTERBELTS IN THE WET SUMMER OF 1968.] Agric. Met. 7 (3): 235-53. [7 refs. O.R.S.]
Belts consisting of 1 row of Poplars with 2-3 rows of shrubs were adequate and are recommended.

Lange, O. 1964. DIE AUSWIRKUNG DES GRUNEN PLANES AUF DEN PAPPELANBAU IM BEREICH DES LWK-FORSTAMTES DUREN. Forst- u.Holzwirt, Hann. 19 (3): S.47.

Logginov, B. I. 1964. PRINCIPLES OF FIELD-PROTECTIVE FORESTATION. Israel Program for Scientific Translations, Jerusalem. Distributed by Oldbourne Press, London. pp. 302. 230 refs. Price L. 15 8 s. Translation by A. Gourevitch of Osnovy polezaseitnogo lesorazvedenija.
A detailed compilation of Soviet experience, discussing the design, lay-out and establishment of shelterbelts and the importance of correct choice and mixture of species.

Mendes, F. L. [Louro Mendes, F.] 1974. [SHELTERBELTS IN THE MIRA IRRIGATED AREA: GENERAL CONSIDERATIONS AND EXAMPLES.] Publicacoes, Direccao Geral dos Servicos Florestais e Aquicolas (1962-65) 29/32, 119-207 + 3 fig. [Pt.f., 13 ref.]
Describes the existing stands and shelterbelts and discusses the prospects for the development of the shelterbelt system.

Pavlovskij, E. S. 1965. VYRASCIVANIE ZASCITNYH NASAZDENIJ V KAMENNOJ STEPI. [GROWING PROTECTIVE STANDS IN THE KAMENNAJA STEPPE.] Izdatel stvo 'Lesnaja Promyslennost', Moscow. pp. 170. 52 refs. [Ru.] N.L.L.
Reviews the work done and experience gained in > 70 years' activity in growing shelterbelts.

Ponticelli, P. 1968. [THE WORK OF THE NATIONAL PULP AND PAPER CORPORATION IN SARDINIA IN THE FIELDS OF AGRICULTURE AND FORESTRY.] Cellulosa e Carta 19 (9): 54-9. [It.]
A short account of the Corporation's work on developing the use of Poplars and Eucalypts for farm windbreaks.

Shah, S. R. H., and Kalra, Y. P. 1970. NITROGEN UPTAKE OF PLANTS AFFECTED BY WINDBREAKS. Plant & Soil 33 (3): 573-80. [E.f., 11 refs.]
N uptake was compared in strawberry plants in Manitoba in unprotected zones and in zones protected by shelterbelts.

Simunovic, N. 1967. [CHARACTERISTICS OF POPLARS, AND THEIR USE IN WINDBREAKS.] Sum. List 91 (5/6): 244-52. [19 refs. [Serb.serb.g.] 1 photo. 5 sets of dgms.]
Poplars are suitable for windbreaks because of their resistance to windbreakage and windthrow, their strong crowns and good height growth, and their fast growth and long life.

Simunovic, N. 1967. [WINDBREAKS OF POPLARS AND WILLOWS IN THE REGION OF VOJVODINA.] Topola, Beograd 11 (61/64): 120-6. [2 refs. [Serb.serb.f.].]
Gives tabulated figures showing the increased timber production expected from planting shelterbelts in the region.

Vasil'ev, M. E. 1969. SHELTERBELTS AND EVAPORATION OF SNOW FROM FIELDS IN NORTH KAZAKHSTAN. Vestnik Sel skohozjajstvennoj Nauki, Moskva (9), (53-7). [Ru.e.g.f. From abstr in Soils and Fertil. 33 (1), (No. 801).]
At a distance from the shelterbelt of 30 times its height, an open belt of Poplars decreased evaporation by ca. 25% and a compact belt of Poplars and other deciduous trees by ca. 22%.

268 PASTURED FORESTS. GRAZING ON FOREST AND OPEN RANGES

268.5

Lancaster, R. 1969. POPLAR LEAVES AS SILAGE. Soil and Water 6 (1 and 2): 28.

27 ARBORETA, ARBORICULTURE FOR ORNAMENTAL PURPOSES

Foley, T. A. 1970. THE USE OF HARDWOODS FOR AMENITY SHELTER AND TIMBER PRODUCTION. Farm For. 12 (2): 28-45 [3 refs.]
Discusses the possibility of combining the provision of shelter with the production of high-grade exotic hardwood timber or veneer in New Zealand.

Gruneberg, H. 1974. [PREPARATORY TREATMENT AND TRANSPLANTING OF LARGE TREES FOR THE LAND SCAPING OF RESIDENTIAL AREAS: A TASK ASSIGNED TO THE STATE FOREST ENTERPRISES BY THE E. GERMAN GOVERNMENT.] Beitrage fur die Forstwirtschaft 8 (4): 193-196 [De.ru.e., 15 ref.]
Reviews government policy on tree planting in urban areas. Poplars are recommended as the best species for the short term, with progressive conversion to other species.

Anonymous. 1964. [THE POPULETUM OF EGENHOVEN.] Bull. Soc. For. Belg. 71 (12): 503-8. [F.]
Lists the Poplars planted and gives some data on increment at ca. 10 years.

Hoffmann, E. 1972. [THE POPLAR COLLECTIONS OF THE FORSCHUNGSINSTITUT FUR PAPPELWIRTSCHAFT, HANN. MUNDEN [, WITH TABLES OF THE SPECIES AND CLONES REPRESENTED].] Holzzucht 26 (3/4): 30-32. [De.]

272 PARKS

Cinovskis, R. 1972. [SURVEY OF INTRODUCED SPECIES OF POPULUS IN RURAL AND URBAN PARKS OF LATVIA.] Riga Zinat Akad. Bot. Sad. Daildarznieciba 9: 25-32. [Lav.]

3 WORK SCIENCE. HARVESTING OF WOOD: LOGGING AND TRANSPORT. FOREST ENGINEERING

32 FELLING AND RELATED OPERATIONS

322 PREPARATORY MEASURES OTHER THAN MARKING. FELLING SEASON

Markovic, J. S. 1970. [STUDY ON STANDARD TIMES FOR CLEAN BARKING OF POPLAR AND WILLOW PULPWOOD BY HAND.] Topola (81/82), (27-34). [Sh.f., 11 ref.]
In continued work standard times were determined for barking unsorted round and cleft billets of Salix alba and various Poplars.

Rotaru, C. 1971. [INVESTIGATIONS ON THE CHEMICAL BARKING OF TREES.] Rev. Padurilor 86 (3): 129-32 + smries.). [Ro.ru.f.e.de., 7 ref.]
Reports trials in Rumania on hybrid Black Poplar ages 20 years. Na arsenite was effective, preferably in 30% solution. Economic aspects are discussed in relation to mechanical barking.

322.3

Berlyn, R. W. 1966. BARK REMOVAL STUDIES AT THE INSTITUTE (PULP AND PAPER RESEARCH INSTITUTE OF CANADA). Trend 7: 10-13.
Bark-to-wood bonding strength are described in detail.

323 FELLING AND SUBSEQUENT PRIMARY CONVERSION

Bozdech, J. 1964. [ASSESSING LOSS OF [WOOD] VOLUME IN BARKING.] Prace Vyzkum. Ust. Lesn. CSSR No. 28, (281-307). 12 refs. [Cz.ru.e.]
Gives figures from a study of the hand barking and machine barking. Losses in hand barking were 1-3% vs. 2-7% by machine.

33 DEGREE OF UTILIZATION AND WASTE

oung, H. E. 1964. [AMOUNT OF FIBRES IN THE ROOTS [AND THER LOGGING RESIDUES] OF 8 SPECIES FROM EASTERN . AMERICA.] Norsk Skogbr. 10 (7/8): 239-43. 6 refs. [Nor.]

331 DEGREE OF UTILIZATION AND WASTE: GENERAL

ilf, H. H. 1966. UBER DIE MAXIMALE ERZEUGUNG UND PTIMALE VERWERTUNG VON PAPPEL-SCHWACHHOLZ. olzzucht, Reinbek 3/4, 35-36. [3 Abb.]

35 PERFORMANCE MEASUREMENTS FOR DETERMINING PIECE RATES IN FELLING AND RELATED OPERATIONS

revosto, M. 1970. [THE INFLUENCE OF MECHANIZATION ON THE TIMES AND COSTS OF LOGGING POPLAR STANDS IN THE LOMBARDY-PIEDMONT PLAIN.] Cellulosa e Carta 21 (7): 14-26. [It.f.e.g.]
Tabulates and discusses data from a study in two 10-year-old Poplar stands in the Po valley.

36 TOOLS, MACHINES AND EQUIPMENT FOR FELLING AND RELATED OPERATIONS

Curro, P., and Ghisi, G. 1966. [TIME STUDY ON CHAIN-SAW OPERATIONS IN A POPLAR PLANTATION.] Pub. Centro Sper. Agric. For. 9: 69-79. [It.it.e.]

Pahlitzsch, G., and Peters, H. 1966. [INVESTIGATIONS ON CUTTING WITH CHAIN SAWS. 1. INFLUENCE OF WOOD MOISTURE CONTENT, CUTTING DIRECTION AND FEED SPEED IN CHAIN SAWING.] Holz Roh-u. Werkstoff 24 (2): 59-71. 37 refs. [G.g.e.] P.R.
Describes investigations on (a) scratch-type and (b) chipper-type chains cutting Spruce, Poplar, and Beech on a special test rig.

Pahlitzsch, G., and Peters, H. 1968. [INVESTIGATIONS ON CUTTING WITH CHAIN SAWS. 2. INFLUENCE OF THE CUTTING ANGLES AND THE IMPORTANCE OF THE CHIP-THICKNESS-LIMITER IN CHAIN SAWING.] Holz Roh- u. Werkstoff 26 (10): 382-8. [2 refs. [G.g.e.] P.R.]
With scratch-type saws the effect of front bevel angle of the tooth on total cutting force (t.c.f.) was more marked in cutting Poplar (m.c. ~90%) than Spruce (m.C. _ 35%). This further work emphasizes the advantages of the chipper-type saw.

Szilagyi, B. 1974. [COMMINUTION OF [PRUNING] SLASH WITH THE RZ-1,5 ROTARY STRAW CHOPPER.] Erdo 23 (5): 223-225. [Hu.ru.e.]
Describes trials of this Hungarian-made implement for reducing the bulk of slash between the rows after pruning hybrid Black Poplar. The operation was done in a single pass at a rate of 0.365 ha/hour.

37 TRANSPORT

372/377

Baldini, S. 1973. [TIMES TAKEN IN THE CONVERSION OF A POPLAR STAND BY THE WHOLE-TREE LOGGING METHOD.] Cellulosa e Carta 24 (3): 21-36. [It.f.e.de., 7 ref.]
Describes a system for felling Poplar and converting the wood into chips at landings. It is based on the use of power saws, an articulated wheeled tractor, a self-propelled barker, a hydraulic crane and a chipper.

38 FOREST ENGINEERING

384 PROTECTIVE WORKS

Holovchans'kyi, I. M., and Kovalenko, A. I. 1972. USING POPULUS HYBRIDS FOR PROTECTIVE PLANTINGS. Visnyk Sil's kohospodar Nauk 3: 72-76. [Ukr.]

4 FOREST INJURIES AND PROTECTION

Gergacz, J., and Szontagh, P. 1973. [INTEGRATED PROTECTION OF POPLAR PROPAGATION MATERIAL AND PLANTATIONS.] Erdo 22 (5): 222-226. [Hu.ru.e.]
Lists the most dangerous fungal diseases and insect pests of hybrid Black Poplars in Hungary, and describes trials to develop a combined spraying programme against both types of damage.

Kruel, W., and Lyr, H. 1964. [THE INCIDENCE OF FOREST INJURIES IN E. GERMANY AND A PROGNOSIS FOR 1964.] Sozial. Forstw., Berl. 14 (4): 108-11. [G.]
Discusses past and expected injuries by fire, fumes, meterological agencies, diseases and injuries of young plants, older stands, and in Poplar and Willow plantations, with comprehensive lists of fungi and insects.

41 GENERAL TECHNIQUE OF FOREST PROTECTION. TYPES OF INJURY

Atanasoff, D. [Atanasov, D.] 1973. [WITCHES' BROOMS ON STEMS OF ELMS AND OTHER TREES.] Archiv fur Phytopathologie und Pflanzenschutz 9 (4): 241-243. [De.e.ru., 3 ref. NLL]
It is suspected that the disorder is attributable to viruses or to a combination of these and mycoplasma. In vegetatively propagated Poplars it was found on some sites and not on others.

Baudys, E. 1967. [MORE INFORMATION ON THE OCCURRENCE OF GALLS[ZOOCEEIDIA] ON POPLAR AND ASPEN IN MORAVIA.] Sborn. Vysoke Skoly Zemed., Brno (Rada C) 36 (2): 153-64. [13 refs. [Cz.ru.g.]
Gives descriptive notes on gall types not previously reported from Moravia, and maps their occurrence.

Emschermann, F. 1972. [ACTUAL PROBLEMS OF PLANT PROTECTION IN POPULUS MANAGEMENT.] Holzzucht 26 (1/2): 11-15. [G.]

414 CHEMICAL CONTROL

414.4

Keller, I. 1964. BEEINFLUSSEN INSEKTIZIDE DIE PHOTOSYNTHESE UND TRANSPIRATION VON PAPPELBLATTERN? Anz. Schadlingskde., Berl.u.Hamb. 37 (6): 87-89. [2 Abb., 1 Tab., Lit. Ang., Franz.u.e.Zsfg.]

Kiss, L. 1969. THE EFFECT OF INSECTICIDES ON POPLAR CUTTINGS. Transl. Dep. For. Can. No. 324, pp. 6. [2 figs. 1 tbl. Transl. from Erdo 1968 17 (1), (26-9). [See F.A. 29 No. 5929.].]

Magnani, G. 1967. [DAMAGE IN A POPLAR NURSERY CAUSED BY HERBICIDE.] Cellulosa e Carta 18 (4): 29-31. [2 refs. [It.it.f.e.g.] 5 photos.]
Describes and illustrates typical damage to Poplar nursery stock after chemical weeding.

Rohmeder, E. 1967. [HARMFUL EFFECTS OF A HERBICIDE ON THE HEALTH AND PERFORMANCE OF YOUNG POPLAR PLANTS.] Forstwiss. Cbl. 86 (4): 193-201. [G.g.] [5 tbls.]

416 TYPES OF INJURY

Gerhard, H. 1964. DIE BEDEUTUNG DER BLATTKRANKHEITEN FUR NORDDEUTSCHLAND. Holzzucht, Reinbek 18 (3/4): 20-21. [Photogr.]

416.1

Weisgerber, Horst. 1967. DIE TRIEBSPITZENKRANKHEIT AN PAPPELN DER SEKTION LEUCE DUBY, VERURSACHT DURCH POLLACCIA RADIOSA (LIB.) BALD.ET CIF. Diss. Forstl. Fak. Georg-August-Unov. Gottingen, Hann.Munden 110 S., [Abb., Tab., 80 Lit. Ang.]

416.13

Harper, A. M. 1966. THREE ADDITIONAL POPLAR GALL APHIDS FROM SOUTHERN ALBERTA. Canad. Ent. 98 (11): 1212-4. [12 refs. Smry. 4 photos.]
Describes Asiphum sacculi on leaves of Populus tremuloides, Thecabius populiconduplifolius on leaves of P. balsamifera and Pemphigus bursarius on leaves of P. nigra var. italica.

416.15

Grisjuk, N. M., and Bulgakova, T. E. 1967. [RESISTANCE OF POPLARS TO RUST.] Lesn. Hoz. 20 (2): 64-6. [Ru.] [1 tbl.]

416.4

Zalasky, H. 1971. FROST RING RESULTING IN A DESTRUCTIVE CANKER OF POPLAR. Abstr. in Proceedings, 37th Session, Canadian Phytopathological Society, Edmonton (24). [IMI]

42 INJURIES FROM INORGANIC AGENCIES (EXCLUDING FIRES)

Taris, B. 1964. [THE ENEMIES OF POPLARS.] Bulletin Technique d'Information des Ingenieurs des Services Agricoles, Paris No. 193, (773-6, liv). [F.f.] C.G.B.
Discussion of the effect of wind, frost, hail, sun-scorch, drought, excessive moisture, insect pests, mammals, birds etc., including suggestions for prevention and control, notes on the susceptibility of varieties, etc.

421 AIR CURRENTS

Erglis, D., and Matuzanis, J. 1973. [STAND WINDFALL RESISTANCE IN 1967.] Jaunakais Mezsaimnieciba 15: 53-60. [Latv.e.]

Kohan, S., and Leontovyc, R. 1967. [THE PROBLEM OF WIND DAMAGE TO POPLARS.] Lesn. Cas., Praha 13 (7): 647-58. [12 refs. [Slovak.slovak.ru.e.g.f.].]
A report on a survey of the occurrence and severity of injuries caused by wind in Poplar stands in the E. Slovakian plain: (1) physiological effects and (2) mechanical damage. Recommendations are made for protective measures.

422 TEMPERATURE INFLUENCES. INSOLATION

Fakirov, V. 1972. [FROST CRACKS IN HYBRID BLACK POPLAR ON FLOODED AND DRAINED SITES ALONG THE DANUBE.] Gorsko Stopanstvo 28 (9): 19-25. [Bulg.]
An analysis was made of the incidence of frost crack in plantations of several different clones planted at various spacings in Bulgaria. Clonal differences were not observed, but cracks were more frequent on drained sites and in denser plantations.

Krzysik, F., Ermich, K., and Zelawski, W. 1964. [FROST DAMAGE TO FOREST STANDS IN THE 'WINTER OF THE CENTURY'.] Las Polski 38 (9): 7-9. 2 refs. [Pol.]

Meiden, H. A. van der. 1965. [DAMAGE TO POPLARS BY LATE FROSTS [IN THE NETHERLANDS].] Populier, Wageningen 2 (1): 6-8. [Du.]
Briefly discusses the degree of damage to various clones in 1962, when severe frosts in early March followed a mild period in Jan. – Feb.

Veselovskii, V. A., and Tarabrin, V. P. 1971. [A BIOPHYSICAL METHOD OF EVALUATING THE RESISTANCE OF WOODY PLANTS [TO HIGH TEMPERATURES].] Lesoved. (1), (80-2). [Ru.e., 6 ref.]
A note describing experiments on the ultra-weak spontaneous luminescence of rootlets of several species, including Populus, as the temperature was raised from 20 to 60° C.

422.1

Gondocs, I. 1971. NYARAK FAGYREPEDESE ELLENI TOREKVES JUGOSZLAVIABAN; CONTROLLING FROST CRACK IN POPULUS IN YUGOSLAVIA. Erdo 20 (9): 404-407. [Hu.]

423 PRECIPITATIONS

Gill, D. 1974. SNOW DAMAGE TO BOREAL MIXEDWOOD STANDS IN NORTHERN ALBERTA. Forestry Chronicle 50 (2): 70-73. [E.f., 16 ref.]
Relates damage to available data on temperature, precipitation and wind-speed, and discusses the influence of species, crown form, stand density and degree of site exposure on the losses sustained.

424 SOIL CONDITIONS; EROSION EFFECTS

Anonymous. 1966. COPPER DEFICIENCY IN POPLARS. Agric. Gaz. N.S.W. 77 (11): 697. [I.M.I.]
Foliar analysis of young Poplars showing marked Cu deficiency symptoms in a New South Wales nursery suggests that these symptoms will occur at Cu contents of < 5 p.p.m. Treatment with $CuSO_4$ at ½lb./tree stimulated growth.

Altherr, E. 1971. [DAMAGE TO YOUNG POPLAR STANDS IN THE HARDTWALD, KARLSRUHE, BY [LOWERING OF] THE WATER TABLE.] Forst- u.Holzw. 26 (11): 213-7. [De., 6 ref.]

Giulimondi, G. 1972. [THE YELLOWING OF POPLAR IN THE NURSERY.] Cellulosa e Carta 23 (7): 11-15. [It.f.e.de.]
The symptoms were attributed mainly to the presence of stagnant water in the soil and the consequent imbalance in the supply of N and other nutrients to the plants.

Jaro, Z. 1967. [THE RELATIONSHIP OF DEFICIENCY DISEASES TO SITE.] Proc. 14th Congr. Int. Union For. Res. Organ., Munich 1967 Pt. II, Sect. 21, (239-45). [G.g.]
A study of Poplars and Pines from two sites showed that leaf nutrient content was closely related to site differences, but also varied between species. Symptoms and amounts of nutrients in leaves on affected sites are discussed.

Popescu, I., and Necsulescu, H. 1967. [THE HARMFUL EFFECT OF PROLONGED INUNDATION ON PLANTATIONS OF HYBRID BLACK POPLARS IN THE BRAILA MARSHES.] Rev. Padurilor 82 (1): 20-3. [Ro.]
The use of resistant clones and large planting stock is recommended for sites likely to be flooded for long periods.

424.18

Rehak, J. 1964. [METHOD OF DETERMINING BRANCH VOLUME.] Lesn. Cas., Praha 10 (10): 927-40. 6 refs. [Cz.cz.ru.e.f.]
'Tariff tables' are constructed for each species, showing the branch volume for d_o values of 3·0, 3·1, 3·2 . . . 7·0 cm.

424.2

Altherr, E. 1971. [GROUND WATER DAMAGE IN YOUNG POPLAR STANDS OF KARLSRUHE HARDWOOD FOREST.] Holzzucht 25 (2/3): 27-29. [G.]

424.9

Dimitri, L. 1973. [THE SALT TOLERANCE OF VARIOUS POPLAR AND WILLOW SPECIES AND CLONES IN THE LABORATORY AND FIELD.] Eur. J. For. Pathol. 3 (1): 24-38. [G.e.]

Gunther, K. H., and Troll, V. 1971. EIN MODELL ZUR BERECHNUNG DES GRUNDWASSERSENKUNGSEINFLUSSES AUF DAS WACHSTUM VON BAUMEN. Essen: W. Girardet 58-59, [1 Abb.] Schriftenr. Landesamt Immissions-Bodenschutz Nordrhein-Westfalen H.23.

425 CHEMICAL INFLUENCES (ATMOSPHERIC)

Dassler, H. G. 1967. [THE RELIABILITY OF EXPERIMENTAL TESTS OF RESISTANCE [TO FUME DAMAGE].] Arch. Forstw. 16 (6/9): 781-5. [9 refs. [G.].]
Compares damage ratings assessed in the field near industrial sources of SO_2 with those found experimentally at controlled SO_2 concentrations.

Dimitrovsky, K. 1965. [THE EFFECT OF INDUSTRIAL FUMES ON FORESTRY IN LIGNITE-MINING AREAS.] Lesn. Prace 44 (7): 314-6. [Cz.]
Populus X robusta, P. trichocarpa, P. X berolinensis, P. X marilandica, are among the trees which show good resistance to the effects of industrial fumes.

ochinger, L. S., Townsend, A. M., Seegrist, D. W., and Bender, W. 1972. RESPONSES OF HYBRID POPLAR TREES TO ULFUR DIOXIDE FUMIGATION. J. Air Pollut. Contr. Assoc. 2 (5): 369-371.

nse, A. R. P. 1969. [DAMAGE TO STREET PLANTATIONS BY ATURAL GAS.] Meded. Rijksac. Landbouww. Gent. 34 (2): 05-15. [Du., C.G.B.]
iscusses the dangers to street trees in the Netherlands arising from ie change-over to natural gas.

hnsen, I., and Sochting, U. 1974. INFLUENCE OF AIR POLUTION ON THE EPIPHYTIC LICHEN VEGETATION AND ARK PROPERTIES OF DECIDUOUS TREES IN THE COPENAGEN AREA. Oikos 24 (3): 344-351. [E.ru., 26 ref. OZ]

ozyukina, Zu. T., and Obrazisova, V. I. 1971. [DAMAGE TO OODY PLANTS CAUSED BY FUMES FROM THE COKE/OAL-TAR INDUSTRY.] Uch. Zap. Perm. Univ. No. 256, (191-6). Ru., From abstr. in Referat. Zh. 1971 (9.56.86). Ru. NLL]
he species studied, in [descending] order of resistance to fumes, ere Ligustrum [vulgare], 'Acacia' [Robinia pseudoacacia], Morus ., Ailanthus [altissima], Populus sp., Sambucus sp.

ampadius, F., Pelz, E., and Pohl, E. 1970. [THE PROBLEM OF STIMATING AND DEMONSTRATING THE RESISTANCE OF OREST TREES TO FUMES.] Biol. Zbl. 89 (3): 301-26. [G.e., 19 fs., E.M.B.]
esults emphasize the complexity of the problem of assessing esistance: for valid interpretation of such data it is essential to take nto account the extent, age, and type of material investigated, and ie duration of the investigations.

inzon, S. N. 1971. ECONOMIC EFFECTS OF SULFUR DIOXIDE N FOREST GROWTH. J. Air Pollut. Control Ass. 21 (2): 81-6. [8 ef., NLL]

tanescu, V., and Nicu, M. 1965. [SILVICULTURAL PROBLEMS N THE ZONE EXPOSED TO THE ACTION OF POISONOUS ASES FROM THE VICTORIA CHEMICAL WORKS.] Rev. adurilor 80 (5): 258-62. [Ro.]
escribes the damage sustained by the natural vegetation in the eighbourhood of this factory, and the results of trial plantations of pecies that might be more resistant, including hybrid poplars.

Vood, F. A., and Coppolino, J. B. 1972. THE RESPONSE OF 11 [YBRID POPLAR CLONES TO OZONE. [Abstract]. Phytoathology 62 (5): 501-502. [E.]
The clones were exposed to O_3 at 0.25 nl/ml for 4 hours at 24°C, 75% r.h., and illumination of 3300 ft-candles. The clones were lassed into three groups on the basis of severity indices.

425.1

Cress, L. W. 1972. RESPONSE OF HYBRID POPLAR TO EQUENTIAL EXPOSURES TO OZONE AND PAN. M.S. Thesis. he Pennsylvania State University, 39 p.

ensen, K. F., and Dochinger, L. S. 1974. RESPONSES OF HYRID POPLAR CUTTINGS TO CHRONIC AND ACUTE LEVELS F OZONE. Environ Pollut 6 (4): 289-295.

hba, K., and Murai, M. 1966. [STUDIES ON RADIO-ENSITIVITY OF FOREST TREES (II). GROWTH AND OMATIC MUTATIONS OF ALNUS, POPULUS AND BETULA PECIES UNDER CHRONIC GAMMA IRRADIATION IN A AMMA FIELD.] J. Jap. For. Soc. 48 (1): 12-9. [18 refs. Jap.jap.e.e.].]
even somatic mutations affecting leaves were detected under a dose f 50-70 r/day, apparently the optimum radiation intensity for ausing somatic mutations in broadleaved trees under chronic y-radiation.

43 FOREST FIRES

432 PREVENTION AND CONTROL

Hubener, E., and Joachim, H. F. 1968. [PROBLEMS OF POPLAR LANTING IN LIVE FIREBREAKS.] Sozial. Forstw., Berl. 8 (10): 312-4. [3 refs. [G.g.].]
Discusses E. German experience, extending over 10 years, on live irebreaks in Pine plantations and other Poplar plantings on sites.

435 BENEFITS OF FIRE CONTROL. INJURIOUS EFFECTS OF FIRE

435.3

Morano, N. 1972. [ESTIMATION OF DAMAGE IN A POPLAR PLANTATION IN THE YEAR N.] Ann. Fac. Sci. Agrar. Univ. Stud. Napoli Port, Serv. Quarta (ser 4) 5: 261-297. [It.e.]

44 DAMAGE BY HARMFUL PLANTS. VIRUS DISEASES

Adema, K. 1964. [DISEASES AND PESTS EFFECTING THE QUALITY OF POPLAR WOOD.] Populier 1 (2): 2-3; [Du.]

Bazzigher, G. 1972. KRANKHEITEN DER PAPPEL. BIRMENSDORF, ZH: EIDGEN. ANST. FORSTL. VERSUCHSW., 22 S., [26 Abb., 12 Lit.Ang.]
Ber. Eidgen. Anst. Forstl. Versuchs. Nr. 87.

Denbnovests'kyi, H. I. 1969. SOME PROBLEMS OF PATHOPHYSIOLOGY OF POPLAR INFESTED WITH NECROSIS. Zakhyst. Rosl. 8: 127-132. [Ukr.]

Zalasky, H. 1970. DISEASE PROBLEMS OF POPLAR IN THE WESTERN INTERIOR OF CANADA. Inform. Rep. For. Res. Lab., Edmonton No. A-X-39, pp. 33 + 7 plates. [17 refs.]
Has separate sections on winter injury, mechanical damage, fire injury, hail damage, damage by gall mites, insects, and rodents, Septoria musiva canker, and gall and rough bark of Poplar (Diplodia tumefaciens), with a pictorial guide to symptoms.

441 FOREST WEEDS

Anonymous. 1967. [CHEMICAL PROTECTION IN FORESTRY.] Erdo 16 (6): 241-66. [Hu.ru.g.]
A special number including weed control in 4-year-old poplar plantations.

Gojkovic, G. 1969. [RESULTS OF TRIALS IN THE USE OF THE HERBICIDES DIQUAT AND PARAQUAT IN POPLAR NURSERIES AND PLANTATIONS.] Topola, Beograd 13 (71/72): 31-41. [Serb.e., 13 refs.]
Summarizes results of investigations in 1965-67 on the use of Reglove (21.8% diquat) and Gramoxone (22.5% paraquat) in Jugoslavia.

Halupa, L., and Vlaszaty, O. 1971. [CHEMICAL WEED CONTROL TRIALS IN BAJTI [HUNGARY].] Erdo 20 (9): 408-11. [Hu.]
Trials with Dikonirt plus dalapon and with other weedkillers gave good control of Solidago gigantea and other weeds in hybrid Poplar stands aged 7 to 9 years, but there was little effect on tree growth.

Jodal, I., and Gojkovic, G. 1967. [RESULTS OF STUDIES OVER THREE YEARS ON THE APPLICATION OF SIMAZINE IN POPLAR NURSERIES.] Topola, Beograd 11 (61/64): 127-38. [5 refs. [Serb.serb.f.f.].]
Simazine applied (mainly to Populus 'I-214') at 2, 3 and 5 kg./ha. in 1962-64 caused such serious reductions in height and diam. growth that its use is not recommended.

Kolster, H. W. 1967. [BRANCH AND STEM DISTORTIONS IN POPLAR AFTER THE USE OF GRAMOXONE FOR WEED CONTROL.] Populier, Wageningen 4 (4): 60-2. [Du.]
Describes, with illustrations, the damage caused to 1-year Poplars, and concludes that two major factors were the use of too high a pressure in spraying and spraying late, when the grass was already high.

Oldenkamp, L. 1966. [DO NOT USE PREFIX FOR SELECTIVE WEED CONTROL IN PLANTATIONS.] Ned. Bosb. Tijdschr. 38 (12): 461-2. [Du.e.]
Prefix (active principle 2, 6-dichlorothiobenzamide) has been successfully used to control weeds in Dutch forests. However, damage was observed on many trees in treated stands. Poplars are particularly susceptible, and the substance should not be used in any plantations at present.

Tauchnitz, E. 1965. [COST FIGURES AS A GUIDE TO THE ECONOMIC USE OF HERBICIDES.] Sozial. Forstw., Berl. 15 (1): 25-9. [G.]

Presents tables comparing costs of different herbicides applied by knapsack sprayers, brushes, mechanical or horse-drawn sprayers, tankers, and other equipment, in plantations.

Tauchnitz, E. 1965. [USING HERBICIDES WITHOUT WATER.] Sozial. Forstw., Berl. 15 (11): 350-2. 10 refs. [G.]

Timmermans, V. 1967. [THE USE OF PREFIX AS A WEED-KILLER.] Populier, Wageningen 4 (1): 11-2. [Du.]
Gives some examples of damage in 1966 to young Poplar cultivars on plots treated with Prefix.

Uhlig, S. K. 1964. [TRIALS WITH HERBICIDES IN POPLAR GROWING.] Arch. Forstw. 13 (12): 1283-9. [G.g.ru.e.]

442 PARASITIC (HIGHER) PLANTS. CLIMBERS AND EPIPHYTES

Anonymous. 1969. PROTECTION OF POPLAR CULTURE FROM PARASITES. Cuneo. Cam. Com. Indus. Agr. Not. Camerale. 24 (20): 1193-1196. [It.]

Becker, H., and Jurzhza, G. 1972. [INVESTIGATIONS WITH THE SCANNING ELECTRON MICROSCOPE ON THE CONTACT ZONE BETWEEN MISTLETOE (VISCUM ALBUM) AND THE VASCULAR SYSTEM OF THE HOST.] Z. PflKrankh. 79 (1), (27-33). [De.e., 1 ref. EMB]
Gives the results of studies of V. album, ca. 6 years old, parasitizing Poplar and Pine branches ca. 2 cm in diameter.

McCartney, W. O., Scharpe, R. F., and Hawksworth, F. G. 1973. ADDITIONAL HOSTS OF VISCUM ALBUM, EUROPEAN MISTLETOE, IN CALIFORNIA. Plant Disease Reporter 57 (10): 904 [E., 3 ref.]
Reports Alnus rubra, Populus fremontii, and Salix lasiandra as new hosts native to California. On the basis of inoculation tests, Populus tremuloides was also found to be susceptible.

442.1

Torgersen, T. R., and Beckwith, R. C. 1974. PARASITOIDS ASSOCIATED WITH THE LARGE ASPEN TORTRIX, CHORISTONEURA CONFLICTANA IN INTERIOR ALASKA. Can. Entomol. 106 (12): 1247-1265.

443 FUNGI AND BACTERIA

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olatile substances were obtained from pulped bark and buds, and rom aqueous extracts of branches of Poplar hybrids known to be esistant, susceptible, or very susceptible to infection by C. hrysosperma.

Danilewicz, K. 1967. ETIOLOGY OF SOME BACTERIAL DISEASES OF POPLAR IN POLAND. I. BACTERIOSIS CAUSED BY PSEUDOMONAS MIGULA AND ERWINIA WINSLOW. Acta Microbiologica Polonica, Warszawa 16 (1): 73-81. [14 refs. [E.e.pol.] I.M.I.]

Danilewicz, K., and Siwecki, R. 1969. A NEW METHOD OF STANDARDIZED INOCULATION OF ROOTED POPLAR CUTTINGS BY THE FUNGUS CHONDROPLEA POPULEA (SACC.) KLEB. (DOTHICHIZA POPULEA SACC. ET BRIARD.) IN ORDER TO CHECK THEIR RESISTANCE. Acta Soc. Bot. Polon. 38 (3): 517-22. [E.pol., 6 refs. O.B.D.]
Rooted cuttings of 13 Poplar clones were inoculated by applying centrifuged, homogenized mycelium in May to a fresh wound made by cutting off one of the lower green shoots.

Danilewicz, K., and Siwecki, R. 1970. [BACTERIAL CANKER OF POPLARS.] Sylwan 114 (6): 39-45. [Pol.ru.e., 28 refs.]
Reviews European literature on the disease (caused by Aplanobacterium populi and Erwinia cancerogena).

Danilewicz, K., and Siwecki, R. 1970. STUDIES ON THE RESISTANCE OF POPLAR HYBRIDS TO APLANOBACTERIUM POPULI (SMITH) STRAIN RIDE. Acta Soc. Bot. Polon. 39 (4): 653-65. [E.pol., 14 refs. O.B.D.]
Artificial-inoculation experiments with A. populi were carried out in 1968 and 1969 on 18 hybrids of the sections Aigeiros and Tacamahaca. Details of results are given in tables and graphs.

Denbnoveckij, G. Ju. 1966. [THE DOTHICHIZA NECROSIS OF POPLARS AND ITS PATHOGEN.] Bot. Z. 51 (2): 291-2. 5 refs. [Ru.]
A note on symptoms and injuries, and the morphology and biology of D. populea, concluding that it is the imperfect stage of the pyrenomycete Cryptodiaporthe populea.

Denbnoveckij, G. Ju. 1970. [CRYPTODIAPORTHE NECROSIS OF POPLARS.] Mikol. i Fitopat. 4 (4): 330-4. [Ru., 16 refs. N.L.L.]
Reviews Russian and European literature on this disease and the fungus that causes it (Dothichiza populea; perfect stage C. populea).

Dochinger, L. S., and Bender, F. W. 1972. ADDITIONAL HYBRID POPLAR HOSTS OF FUSARIUM CANKER IN OHIO. Plant Disease Reporter 56 (6): 523-524 [E., 5 ref.]
A survey in 1967 showed that cankers caused by F. solani were present on all surviving trees in an experimental plantation of 50 hybrid Poplar clones established on a calcareous spoil bank on strip-mined land near Cadiz, Ohio, in 1951. The 31 clones on which natural infections were observed are listed.

Donaubauer, E. 1964. [STUDIES ON THE SUSCEPTIBILITY OF VARIOUS POPLAR CLONES TO SEPTOTINIA POPULIPERDA.] Repr. from Phytopath. Z. 50 (2): (134-42). 7 refs. [G.g.e.]
Inoculations of leaves of 42 clones showed variations in resistance between clones. The most resistant clones were P. X 'Oxford', 'T. 32', P. 'I 214' and 'T. 41'.

Donaubauer, E. 1965. [THE MARSSONINA DISEASE OF POPLAR IN AUSTRIA.] Allg. Forstztg. 76 (10): Suppl. (Informationsdienst No. 96.) pp. 2. 5 refs. [G.]
Briefly discusses serious infections in Austria by M. brunnea (perfect form Drepanopeziza punctiformis). Observations in trial plantations showed considerable variation in clonal susceptibility.

Donaubauer, E. 1967. [THE SPREAD OF MARSSONINA BRUNNEA AND M. POPULI-NIGRAE.] Proc. 14th Congr. Int. Union For. Res. Organ., Munich 1967 Pt. V, Sect. 24, (279-84). [32 refs. [G.].]
Lists references to the spread of these two fungi in European countries, with a few references also to N. America, Japan, and China.

Dupias, G. 1965. [POPLAR RUSTS IN THE PYRENEES AND THE LOWER PYRENEAN BASIN.] Bulletin Trimestriel de la Societe Mycologique de France, Paris 81 (2): 188-96. [28 refs. [F.] O.B.D.]
Reports inoculation experiments with Melampsora allii-populina, M. larici-populina, M. pulcherrima and M. pinitorqua, and presents notes on their morphology, alternate hosts and regional distribution.

Erdesi, J. 1969. [FROST CRACK AND THE MICROBIAL METABOLISM OF TREES.] Sumarstvo 22 (7/8): 3-19. [Serb.e., 18

refs.]
From studies on various Poplars in Jugoslavia, conclusions are drawn on the effect of pruning wounds and the associated decay on the liability of trees to frost crack. Preventive measures are suggested.

Gojkovic, G. 1970. [RESULTS OF TRIALS AND EXPERIENCE GAINED IN POPLAR PROTECTION IN 1969.] Topola 14 (77/78): 21-4. [Serb.e., 19 refs.]
A review of European literature on chemical control of Cryptodiaporthe (Dothichiza) populea, Marssonina brunnea, Cryptorrhynchus lapathi, and weeds, in plantations and nurseries.

Gojkovic, N. 1971. [THE BIOLOGY OF MARSSONINA BRUNNEA AND THE RESISTANCE OF POPLAR CLONES TO THIS PATHOGEN IN YUGOSLAVIA.] Topola 15 (83/85): 71-3. [Sh.f., 11 ref.]
A summary statement of present knowledge.

Gojkovic, N. 1973. [ON THE INFECTION OF POPLAR BY DOTHICHIZA POPULEA.] Topola No. 95/96, 9-11 [Sh.f., 10 ref.]
A summary account of inoculation trials on 45 Poplar clones [unspecified] in Yugoslavia. Disease symptoms appeared more quickly on plants inoculated with mycelium than on plants inoculated with a suspension of spores.

Gojkovic, N. 1974. [THE NUMBER OF LEAF-SPOTS CAUSED BY MARSSONINA BRUNNEA AS A MEASURE OF THE SUSCEPTIBILITY AND TOLERANCE OF POPLAR CLONES TO THE FUNGUS.] Topola 18 (100/101): 121-122 [Sh.f., 2 ref.]
The number of leaf-spots caused by M. brunnea on standard samples (24 cm^2) of fallen leaves, and also leaf yellowing, were determined for 75 Poplar clones in Yugoslavia, and the results are compared with those for Populus 'I-214' (used as a control).

Gremmen, J. 1964. THE MARSSONINA DISEASE OF POPLAR. 2. INOCULATION EXPERIMENTS ON LEAF DISCS WITH ASCOSPORES AND CONIDIA. Ned. Bosh. Tijdschr. 36 (5): 149-57. 6 refs. [E.du.]
Results show that ascospores and conidia from Poplars of the section Aigeiros can infect other members of the same section. Both ascospores and conidia could infect both sides of the leaves.

Gremmen, J. 1964. THREE POPLAR-INHABITING DREPANOPEZIZA SPECIES AND THEIR LIFE-HISTORY. Nova Hedwigia, Weinheim 9 (1/4): 170-6 + 1 plate. 9 refs. [E.] O.R.S.
Describes and discusses D. populorum, D. populi-albae, and D. punctiformis.

Gremmen, J. 1965. [THE MARSSONINA DISEASE OF POPLAR. 3. THE OCCURRENCE OF M. BRUNNEA IN THE NETHERLANDS.] Ned. Bosh. Tijdschr. 37 (6): 196-8. 6 refs. [Du.e.]

Gremmen, J., and Kam, M. de. 1974. RESEARCH ON POPLAR CANKER (APLANOBACTER POPULI) IN THE NETHERLANDS. PART II. European Journal of Forest Pathology 4 (3): 175-181. [E.de.f., 8 ref.]

Gremmen, J., and Koster, R. 1972. RESEARCH ON POPLAR CANKER (APLANOBACTER POPULI) IN THE NETHERLANDS. European Journal of Forest Pathology 2 (2): 116-124 [E.f.de., 15 ref.]
Reviews research with special reference to resistance tests conducted at De Dorschkamp, Wageningen, including inoculation techniques, the scale of susceptibility used, and some test results.

Grosscurth, W. 1969. BEOBACHTUNGEN UBER DAS AUFTROTEN VON DOTHICHIZA POPULA SACC. ET BR. Holzzucht, Reinbek 23 (2): 24-25, [1 Abb.]

Hennebert, G. L. 1964. [THE IDENTIFICATION OF POPLAR RUSTS.] Agricultura, Louvain 12 (4): 661-70. 10 refs. [F.e.du.] C.G.B.
Discusses the 8 Poplar rusts found in Europe and presents a tentative key based on morphological characters of uredia and telia, without the intention of deciding their taxonomic status.

Hintikka, V. 1974. NOTES ON THE ECOLOGY OF ARMILLARIELLA [ARMILLARIA] MELLEA IN FINLAND. Karstenia 14, 12-31 [E., 76 ref. OBD]

Hubbes, M. 1964. NEW FACTS ON HOST-PARASITE RELATIONSHIPS IN THE HYPOXYLON [PRUINATUM] CANKER OF ASPEN. Repr. from Canad. J. Bot. 42: 1489-94 + 10 photos. 7 refs.

Hubbes, M. 1966. INHIBITION OF HYPOXYLON PRUINATUM (KLOTZSCHE) CKE. BY ASPEN BARK MEAL AND THE NATURE OF ACTIVE EXTRACTIVES. Canad. J. Bot. 44 (4): 365-86. [50 refs. O.R.S.]
One possible explanation of the apparent contradiction between the susceptibility of Aspen to H. pruinatum and the inhibitory power of its bark substances to the fungus is thought to be the occurrence of such substances in a bound, inactivated form.

FAO/Int. Poplar Comm. 1965. MARSSONINA LEAF SPOT DISEASE OF THE POPLAR. Rep. 6th Sess. Wkg. Party Diseases Int. Poplar Comm., Wageningen 1 No. FAO/CIP/MAL 25, pp. 64. [Many refs. [E.F.] 1 dgm. 13 tbls. 3 maps.]
Includes summaries of conditions in Italy, Netherlands and Jugoslavia.

Ito, K., Chiba, I., and Kondo, H. 1969. [NEOFABRAEA CANKER OF POPLARS IN JAPAN.] Bull. For. Exp. Sta., Meguro No. 225, (31-40 + 4 plates). [Jap.e., 5 refs.]
Susceptible species and hybrids (of sections Leuce, Aigeiros and Tacamahaca) are listed.

Joachim, H. F. 1965. [DISEASE AND MORTALITY IN YOUNG STANDS OF POPULUS X BEROLINENSIS.] Sozial. Forstw., Berl. 15 (10): 310-1. 4 refs. [G.]
Discusses chiefly attacks by Pollaccia elegans, causing dieback, growth checks, and death, especially in connexion with other diseases, and recommends replacement by resistant varieties.

Jobling, J., and Young, C. W. T. 1965. APPARENT VARIATIONS IN THE RESISTANCE OF POPLAR CLONES TO BACTERIAL CANKER. Extr. from Rep. For. Res. For. Comm., Lond. 1963/64, (151-7 + 1 photo). 5 refs.
Some Poplar clones rated as very resistant to bacterial canker inoculation tests have proved susceptible to natural infection in the field.

Kalandra, A. 1964. [LEAF-SPOT ON POPLARS CAUSED BY MARSSONINA POPULI-NIGRAE.] Lesn. Cas., Praha 10 (9): 819-22. 4 refs. [Cz.cz.ru.e.span.]
A note on the disease in Czechoslovakia. Various Poplars are attacked, e.g. Populus nigra, P. X marilandica and P. X berolinensis, but injury has not yet been serious enough to justify control measures.

Kalandra, A. 1966. [POPLAR CANKER CAUSED BY A FUNGUS OF THE GENUS HYPOXYLON IN CZECHOSLOVAKIA.] Lesn. Cas., Praha 12 (6): 487-92 + 6 photos). [36 refs. [Cz.cz.ru.e.g.f.].]
A preliminary report on the occurrence of a canker disease on three stems in a 7-year Populus X marilandica plantation in central Bohemia, with a description of the cankers.

Kailides, D. S. 1973. [MARSSONINA BRUNNEA, A NEW DANGEROUS DISEASE OF POPLARS IN GREECE.] Episteminike Epeteris, Geoponike kai Dasologike Shole, Aristoteleion Panepistemion Thessalonikes 15 (2): 57-72 [G.e., 36 ref.]
The disease was found for the first time in Greece in 1971 on Populus 'I-214' in Macedonia, and has since been observed (on other clones also) in Thrace and Thessaly.

Kessler, W. 1966. [THE CAUSE OF BACTERIAL CANKER OF POPLAR, AND TESTING THE RESISTANCE OF POPLAR VARIETIES.] Sozial. Forstw., Berl. 16 (12): 369-71. [7 refs. [G.g.].]
A general account of the disease, its symptoms and mode of infection. The causative agent has been isolated and its identification confirmed as Aplanobacterium populi in E. Germany. Factors affecting host resistance are discussed.

Kessler, W. 1966. [THE OCCURRENCE OF MARSSONINA ON POPLAR [IN EAST GERMANY].] Sozial. Forstw., Berl. 16 (6): 181-3. [10 refs. [G.g.].]
Reports occurrences of M. populi-nigrae and M. brunnea on Populus X berolinensis and unspecified P. X canadensis, and discusses symptoms, susceptibility, and control on the basis of (chiefly Western) literature.

Kessler, W. 1967. [THE OCCURRENCE OF BACTERIAL CANKER OF POPLAR (CAUSED BY APLANOBACTERIUM POPULI) IN EAST GERMANY.] Arch. Forstw. 16 (10): 1057-63.

12 refs. [G.g.ru.e.].]
Describes the isolation and identification of the causal agent, confirmed as A. populi.

Kim, J. W., and La, Y. J. 1969. [STUDIES ON THE ALTERNATE HOST RANGE AND PRIMARY INFECTION BY OVER-WINTERED UREDOSPORES OF POPLAR LEAF RUST FUNGUS, MELAMPSORA SPP.] Research Reports, Forest Research Institute, Seoul No. 16, (109-11). [6 refs. [Kor.kor.e.e.].]

Kobayashi, T., and Chiba, O. 1974. RING SPOT OF POPLARS CAUSED BY PHYLLOSTICTA POPULORUM SACC. ET ROUM. Bulletin of the Government Forest Experiment Station, Meguro No. 268, 1-11 + 3 pl. [E.jap., 5 ref.]
Describes a further and more detailed study of P. populorum in which laboratory and field observations were made on the physiology, pathogenicity and life history of the fungus.

Kolster, H. W., and Meiden, H. A. van der. 1964. [METHODS FOR RATING MARSSONINA INFECTION OF POPLAR.] Ned. Bosh. Tijdschr. 36 (4): 119-21. 3 refs. [Du.e.e.]
The method is based on a system developed by Schreiner for rating rust infection. Criteria are the presence of spots on the leaves, leaf discoloration, and leaf drop.

Koster, R. 1973. [SELECTION FOR RESISTANCE AGAINST BACTERIAL CANKER IN POPLARS.] Populier 10 (1): 5-7 [Nl]
A general account of breeding and selection for resistance to Aplanobacter populi, with special reference to work in Holland.

Kozlowska, C. 1967. [THE HEALTH OF FAST-GROWING TREE SPECIES IN POLAND.] Proc. 14th Congr. Int. Union For. Res. Organ., Munich 1967 Pt. V, Sect. 24, (461-4). [6 refs. [G.].]
Brief notes on diseases of Poplar (Dothichiza populea, Cytospora chrysosperma, Pollaccia radiosa and bacterial canker), and Willow (chiefly Pollaccia [Fusicladium] saliciperda).

Kraayenoord, C. W. S. van. 1974. MELAMPSORA POPLAR LEAF RUST IN NEW ZEALAND. In Research Report for 1973, Ministry of Works and Development, New Zealand. [E.] From Holzzucht 1974) 28, 24. [De.]
Reports the occurrence of M. laricipopulina and M. medusae in New Zealand in 1973, and discusses the susceptibility or resistance of New Zealand clones to these rust fungi, both of which can overwinter in that country.

Kraayenoord, C. W. S. van, Laudon, G. F., and Spiers, A. G. 1974. POPLAR RUSTS INVADE NEW ZEALAND. Plant Disease Reporter 58 (5): 423-427 [E., 6 ref.]
Describes (with a sketchmap) the first appearance and spread of infection by Melampsora medusae and M. laricipopulina throughout North Island, New Zealand in 1973.

Leibundgut, H. 1974. [EFFECT OF THE MARSSONINA FUNGUS ON DIFFERENT POPLAR CLONES.] Schweizerische Zeitschrift fur Forstwesen 125 (4): 263-264 [F.]
A note comparing the severity of Marssonina [brunnea] damage to 7 clones in a trial 10-15 years old in the Reppischtal, Switzerland: Populus 'Robusta' and P. 'Regenerata Harff' were the most resistant.

Leibundgut, H., and Amels, C. W. 1972. [RUST RESISTANCE OF SOME POPLAR CLONES.] Schweiz. Z. Forstw. 123 (4): 255-8. [F., 2 ref.]
In a swiss study on 1 + 1 and 1 + 2 Poplar plants of 16 clones, Populus 'Regenerata Harff' and P. 'Marilandica' were among those most resistant to Melampsora rust; P. 'Robusta', and some Italian cultivars tested, were among the most susceptible.

Leontovyc, R. 1971. INCIDENCE OF IMPORTANT DISEASES OF THE POPLAR SPECIES FREQUENTLY CULTIVATED IN SLOVAKIA. Acta Instituti Forestalis Zvolenensis 2, 407-425. [E.sk.ru.de., 34 ref.]
Discusses the revised Poplar nomenclature now adopted in Slovakia to conform with that used in other countries.

Lloyd, H. L. 1971. NEW RECORDS OF RHODESIAN FUNGI – 1. MELAMPSORA LARICI-POPULINA KLEBAHM. Kirkia 8 (1): 1-2. [2 ref.]
Recorded, for the first time in Rhodesia, in the Salisbury area in 1967 [host not specified], coincident with its first reported appearance in S. Africa.

Lungescu, E. 1970. [POPLAR CANKER CAUSED BY CYTOSPORA CHRYSOPERMA [VALSA SORDIDA].] Studii si Cercetari de Biologie (Seria Botanica), Bucuresti 22 (6): 517-22. [Ro.de., From abstr. in Rev. Plant Path. 51 (5), (No. 1975).]
Observed for the first time in Rumania on 3-year-old seedlings of Populus X euramericana. The best control was with 0·5% Dithane M45.

McMillan, R. 1972. POPLAR LEAF RUST HAZARD. N. Z. J. Ag. 125 (5): 47.

McMillan, R. 1973. POPLAR LEAF RUSTS HERE TO STAY. New Zealand Journal of Agriculture 127 (3): 26-27 [E.] From Review of Plant Pathology 53, 3195.
Presents a map showing the rapid spread of Melampsora medusae and M. Larici-populina throughout N. Island, New Zealand, during March-May 1973, and a table showing the susceptibility of some important Populus cultivars.

Magnani, G. 1964. [THE TOXIC EFFECTS OF THE CULTURE FILTRATE OF DOTHICHIZA POPULEA.] Pubbl. Cent. Sper. Agric. For., Roma 7, (99-116 + 3 plates). 6 refs. [It.it.e.e.]

Magnani, G. 1965. [THE DISTRIBUTION OF MARSSONINA BRUNNEA [ON POPLAR] IN SOUTH-CENTRAL ITALY.] Cellulosa e Carta 16 (3): 11-7. 2 refs. [It.f.e.g.]

Magnani, G. 1966. [A LEAF DISEASE OF POPULUS TREMULA CAUSED BY MARSSONINA TREMULAE.] Pubbl. Cent. Sper. Agric. For., Roma 8, (175-81 + 1 plate). [5 refs. [It.it.e.e.].]
Inoculations of 18 Poplar species or cultivars with M. tremulae, found causing slight damage to lower parts of crowns of P. tremula at Vallombrosa and Vernio (Florence), were negative except on P. tremula.

Magnani, G. 1966. [MARSSONINA BRUNNEA.] Pubbl. Cent. Sper. Agric. For., Roma 8, (121-6 + 1 plate). [4 refs. [It.it.e.e.].]
Preliminary experiments on control with Cupravit and Orthocide were promising.

Magnani, G. 1967. [CYTOSPORA CHRYSOSPERMA INJURY TO POPLAR.] Pubbl. Cent. Sper. Agric. For., Roma 9 (2): 91-6 + 5 photos. [8 refs. [It.it.e.e.] 1 tbl.]

Magnani, G. 1967. [FURTHER OBSERVATIONS ON MARSSONINA BRUNNEA IN SOUTH AND CENTRAL ITALY.] Cellulosa e Carta 18 (3) 23-6. [4 refs. [It.it.f.e.g.] 2 photos.]

Magnani, G. 1967. [A HYPERPARASITE OF A POPLAR RUST.] Cellulosa e Carta 18 (12): 37-9. [1 ref. [It.it.f.e.g.].]
Gives a preliminary report on the occurrence during 1967, in a Poplar nursery near Rome, of a hyperparasitic attack by a Fusidium sp. on the uredosori of a rust fungus (probably Melampsora allii-populina).

Magnani, G. 1967. [NECROSIS AND DIEBACK IN CONIFERS CAUSED BY DIPLODIA PINEA.] Pubbl. Cent. Sper. Agric. For., Roma 9 (3): 209-20 + 7 photos. [11 refs. [It.it.e.e.].]

Magnani, G. 1969. ['BROWN-SPOT' DISEASE OF POPLAR.] Cellulosa e Carta 20 (10): 19-22. [It.f.e.g., 2 refs.]
The disorder called 'tacche vescicolose' ['brown-spot' disease], recognized for ca. 50 years in N. Italy and more recently in central-southern Italy also, is described and illustrated.

Magnani, G. 1970. [A POPLAR RUST HYPERPARASITE.] Pubbl. Cent. Sper. Agric. For. 11 (1): 27-35 + 3 plates). [it.e., 1 ref.]
Reports the isolation of Ramularia uredinis from Poplar leaves attacked by Melampsora allii-populina, and gives the results of physiological tests on the response of R. uredinis to various media.

Magnani, G. 1972. [DAMAGE TO YOUNG POPLARS BY DISCELLA CORONATA.] Pubblicazioni del Centro di Sperimentazione Agricola e Forestale 11 (2): 155-64 + 3 pl. [It.e., 1 ref.]

Magnani, G. 1973. [OCCURRENCE OF DREPANOPEZIZA PUNCTIFORMIS IN CENTRAL AND SOUTHERN ITALY.] Pubblicazioni del Centro di Sperimentazione Agricola e Forestale 12, 231-234 + 2 pl. [it.e., 6 ref.]

Manion, P. D., and Valentine, F. A. 1975. QUANTITATIVE INHERITANCE OF TOLERANCE TO HYPOXYLON MAMMATUM IN ASPENS. [ABSTRACT] Proceedings of the American Phytopathological Society publ. 1 (60-61). [E.]

Marinkovic, P. 1968. [EPIDEMIC OF MARSSONINA BRUNNEA IN NURSERIES AND PLANTATIONS OF EURAMERICAN POPLARS IN 1967.] Topola, Beograd 12 (67/68): 14-8. [5 refs. [Serb.f.].]
Populus 'I-154' was the most susceptible. Zineb S-65 and basic Cu_2OCl_2 gave good control.

Marks, G. C., Berbee, J. G., and Riker, A. J. 1965. COLLETOTRICHUM SHOOT BLIGHT OF POPLARS. For. Sci. 11 (2): 204-15. 31 refs.

Meiden, H. A. van der. 1964. [RESULTS OF RESEARCH ON RUST AND MARSSONINA [DISEASES] IN THE NETHERLANDS.] Holzzucht, Reinbek 18 (3/4): 16-20. [G.g.]
Discusses the spread of Melampsora laricipopulina rust and Marssonina infections, symptoms and development of the diseases, factors (especially meteorological) favouring them.

Minkevic, I. I. 1970. [EVALUATING THE RESISTANCE OF POPLARS TO THE BARK NECROSIS PATHOGEN CYTOSPORA NIVEA.] Lesn. Z. 13 (1): 162-5. [Ru., 13 refs.]
Describes a series of experiments in which a strain of C. nivea from a dead Poplar was used to inoculate 5 different Poplar species and hybrids, and was cultured on aqueous extracts of the bark and wood.

Minkevic, I. I. 1970. [GEOGRAPHICAL POPULATIONS OF CYTOSPORA NIVEA.] Mikol. i Fitopat. 4 (4): 303-9. [Ru., 22 refs. N.L.L.]

Mocanu, V., and Poleac, E. 1965. [STUDIES ON BACTERIAL CANKER OF POPLAR.] Stud. Cerc. Inst. Cerc. For., Bucuresti 25, (211-29). 23 refs. [Ro.e.g.ru.]
Summarizes research on the disease caused by Pseudomonas syringae var. populea, now widespread in Rumania. 'Robusta' clones were particularly susceptible; 'Serotina', 'Marilandica', and 'Thevestina' more or less resistant.

Mocanu, V. V., and Tanase, I. 1969. [BIOCHEMISTRY OF POPLAR (P. X EURAMERICANA EV. ROBUSTA, CLONE R.20), INFECTED WITH DOTHICHIZA POPULEA.] Rev. Padurilor 84 (2): 59-61. [10 refs. [Ro.].]

Mocanu, V., and Tanase, I. 1970. [TESTS FOR EARLY DETECTION OF DOTHICHIZA POPULEA ON NURSERY STOCK OF POPLARS.] Rev. Padurilor 85 (7): 355-9. [Ro., 11 refs.]
D. populea infection causes changes in the metabolism of sugars, proteins and lipids of affected plants as well as in the content of nucleic acids in the tissues even in the early stages of attack.

Mrkva, R. 1966. [CHEMICAL CONTROL OF FUNGUS DISEASES OF POPLAR.] Lesn. Cas., Praha 12 (3): 253-78. [30 refs. [Cz.cz.ru.e.g.f.].]
A number of fungicides were tested against Dothichiza populea in the laboratory and (mainly on cuttings) in the field. As a result of these field trials, Agronal is recommended for treating cuttings.

Murzaev, V. I. 1969. [ETIOLOGY OF BACTERIAL PROLIFERATING CANKER OF STEMS OF ASPEN AND POPLAR.] Nauc. Dokl. Vyss. Skoly (Biol. Nauki), Moskva (4), (99-104). [30 refs. [Ru.] N.L.L.]
Reviews the literature, and describes the investigations on the scrology, culture, morphology and physiology of the pathogen, its specificity, etc. It is concluded that the disease of Aspen and other Poplars is identical, and that the pathogen is Aplanobacterium populi.

Nowacki, M. J., and Fonseca, O. S. 1964. [THE OCCURRENCE OF MELAMPSORA SP. ON POPULUS DELTOIDES VAR. CAROLINENSIS IN CURITIBA.] An. bras. Econ. flor., Inst. Nac. Pinho 16, (156-60). 11 refs. [Port.]
Describes the disease, first found in 1958 in a match-wood plantation, and gives some data on the climate of Curitiba.

Oguchi, T. 1970. [THE SPECIES OF LEUCOSTOMA AND VALSA INHABITING POPLARS IN HOKKAIDO AND THEIR PHYSIOLOGICAL CHARACTERISTICS.] J. Jap. For. Soc. 52 (10): 296-305. [Jap.e., 27 refs.]

O'Riordain, F., and Kavanagh, T. 1965. MARSSONINA LEAF SPOT OF POPLAR. Irish Journal of Agricultural Research, Dublin 4 (2): 233-5 + 3 photos). 11 refs.
Widespread defoliation of Poplar in Ireland has been caused by M. populi-nigrae. Most Populus species and clones examined appear to be susceptible to infection by this leaf-spotting organism.

Otta, J. D., and English, H. 1971. SCROLOGY AND PATHOLOGY OF PSEUDOMONAS SYRINGAE. Phytopathology 61 (5): 4 43-52. [34 ref.]
A study of 450 isolated from >30 host plants (including Poplar) showed 10 distinct serotypes but no clear taxonomic groupings. Both isolates from Poplar, and all those from Syringa vulgaris, belonged to the same widespread serotype IIIa.

Ouellette, G. B. 1967. OCCURRENCE OF CRYPTODIAPORTHE POPULEA, THE PERFECT STATE OF DOTHICHIZA POPULEA, IN QUEBEC. Bi-m. Res. Notes Dep. For. Can. 23 (3): 22. [3 refs.]
Confirms earlier identifications, and should definitely dissociate Cenangium populeum from Dothichiza canker of Poplar.

Pegler, D. N., and Waterston, J. M. 1968. PHELLINUS [FOMES] IGNIARIUS. C. M. I. Descr. pathogen. Fungi Bact., Lond. No. 194, pp. [2]. [9 refs.]
Commonly found on stems of Salix spp. and Populus spp., where it causes white heart rot; also recorded on a wide range of other hardwoods.

Pegler, D. N., and Waterston, J. M. 1968. RIGIDOPORUS [FOMES] ULMARIUS. C. M. I. Deser. pathogen. Fungi Bact., Lond. No. 199, pp. [2]. [3 refs.]
Causes butt rot in Elm and has also been reported on Acer spp., Aesculus spp., Populus spp., Robina spp. and Tilia spp.

Pinon, J. 1973. [POPLAR RUSTS IN FRANCE: CLASSIFICATION AND DISTRIBUTION.] European Journal of Forest Pathology 3 (4): 221-228. [F.de.e., 9 ref.]
Describes a study by interference microscopy of eight species of Melampsora recovered in 1971-72 from Poplars in forests and plantations throughout France. A brief description of the uredospores, paraphyses, hosts and distribution of each species is given and a key to the species is included.

Pinon, J. 1974. [PRELIMINARY OBSERVATIONS ON THE INFLUENCE OF INOCULUM CONCENTRATION ON THE SENSITIVITY OF CULTIVATED POPLARS TO MARSSONINA BRUNNEA.] European Journal of Forest Pathology 4 (1): 54-59. [F.de.e., 3 ref.]

Ride, M. 1967. [BACTERIAL CANKER OF POPLAR IN EUROPE.] Proc. 14th Congr. Int. Union For. Res. Organ., Munich 1967 Pt. V, Sect. 24, (414-26). [F.]
A review of the current situation, citing the literature but without bibliographical references.

Rui, D. 1968. [CONTROL OF MARSSONINA BRUNNEA ON POPLAR.] Agricoltura delle Venezie, Venezia 22 (11/12): 737-47. [It.]
[Cf.F.A. 29 Nos. 877, 4155.] Outlines research on M.brunnea since its appearance in Italy in 1963, describes the conditions of rainfall and temperature most favourable to the disease, and emphasizes the importance of timely chemical control measures in spring.

Savrova, L. A. 1967. [BIOLOGY OF THE PATHOGEN OF ASPEN 'SCAB.'] Mikol. i Fitopat., Leningrad 1 (4): 321-9. [7 refs. [Ru.ru.] I.M.I.]

Schipper, A. L., Jr., and Dawson, D. H. 1974. POPLAR LEAF RUST – A PROBLEM IN MAXIMUM WOOD FIBER PRODUCTION. Plant Disease Reporter 58 (8): 721-723. [E., 5 ref.]

Schlosser, L. A. 1967. [RUST ATTACK ON A POPULATION OF TETRAPLOID POPLARS.] Zuchter 37 (6): 299-300. [[G.g.e.] E.M.B.]

Semb, L. 1968. A NEW FUNGAL DISEASE ON POPLARS IN NORWAY, Gartneryrket [, Oslo] 58 (27), (582-3). [[Nor.e.] From abstr. in Rev. appl. Mycol. 48 (5): 265.]

ezicula populi, observed first in 1964 near Vollebekk on Populus X rolinensis, causes small spots with necrotic tissue embedded in the ark of the previous year's growth, mainly on the lower parts of oung trees or on cuttings.

emb, L., and Hirvonen-Semb, A. 1964. [PARASITIC FUNGI ON EAVES OF POPULUS.] Arsskrift for Planteskoledrift og Den- rologi, Oslo 11, (24-39). [20 refs. [Nor.e.e.] E.M.B.]
escribes the distribution in Norway, Hosts, disease development, mptoms, and (briefly) control.

ang, C. -T. [Hsiang, T. -T.], et al. 1964. [ON THE MARSSONINA EAF-SPOT OF POPLAR NURSERY STOCK.] Acta Phyto- hylacica Sinica, Peking 3 (3): 201-8. 13 ref. [Chin.chin.e.] I.M.I.
he pathogen of the leaf-spot prevalent on nursery stock (seedlings id cuttings) of Poplars in the N.E. provinces of China was entified as M. populicola.

vanesan, A., and Holliday, P. 1972. ROSELLINIA NECATRIX. MI Descriptions of Pathogenic Fungi and Bacteria No. 352, 2 pp. .]
escribes R. necatrix, a white root rot, mainly of temperate fruit ops, but also found on species of Acacia, Castanea, Ulmus, uercus, Populus, Salix and Juglans.

wecki, R. 1968. EFFECT OF BARK WASHING FROM POPU- US 'ROBUSTA' ON THE COURSE OF ARTIFICIAL INOCULA- ION OF SOME POPLAR HYBRIDS BY THE FUNGUS OTHICHIZA POPULEA SACC. ET BRIARD. Acta Soc. Bot. olon. 37 (3): 443-9. [6 refs. [E.e.pol.] O.B.D.]

okolova, E. S. 1966. [SOME DATA ON THE BIOLOGY OF THE UNGUS POLLACCIA RADIOSA [VENTURIA TREMULAE], HE PATHOGEN OF POPLAR 'SCAB'.] Sborn. Rabot Lesn. Hoz. sesojuz. Nauc.-Issled. Inst. Lesovod. No. 51: 98-102. [5 refs. Ru.].]
hemical control treatment should be done at temperatures)5° efore leaf flush, and again during flushing; spraying later in the rowing season should be concentrated on the young leaves and hoots.

outh Africa For. Res. Inst. 1968. [POPLAR RUST.] Extr. from ep. For. Res. Inst. Dep. For. S. Afr. 1967/68, (27).
he occurrence of Melampsora larici-populina is reported for the irst time in S. Africa, on Populus nigra var. italica throughout the S. nd W. Cape and on other Poplars in Natal and the Transvaal. So far he damage is not serious.

Spiers, A. G. 1974. CONTROL OF POPLAR LEAF RUST MELAMPSORA LARICIPOPULINA IN NEW ZEALAND. New Zealand Journal of Experimental Agriculture 2 (4): 433-436. [E., From Review of Plant Pathology 54, 3511.]

Stahl, W. 1968. AN INVESTIGATION ON THE CYTOSPORA DISEASE OF POPLARS IN AUSTRALIA. Aust. For. Res. 3 (2): 3-14. [7 refs. Smry. 3 photos. 3 tbls.]

Sutton, B. C. 1970. FOREST MICROFUNGI IV. A LEAF SPOT OF POPULUS CAUSED BY CLADOSPORIUM SUBSESSILE. Canad. J. Bot. 48 (3): 471-7. [E.f., 25 refs. O.R.S.]
Phaeoramularia maculicola comb. nov) syn, C. subsessile, is pro- osed for a fungus causing leaf-spot of various Poplars in Canada, he U.S.A. and Sweden. The symptoms are difficult to distinguish rom those of the shoot and leaf blight caused by Pollaccia radiosa.

Suzuki, K. 1973. STUDIES ON THE SUSCEPTIBILITY TO POPLAR LEAF RUST INFLUENCED BY DIFFERENT NU- TRIENT CONDITIONS (I). CHANGES OF SUSCEPTIBILITY INDUCED BY NUTRIENT DEFICIENCY. Journal of the Japanese Forestry Society 55 (1): 29-34. [E.jap., 16 ref.]
Results showed that, except for the most resistant clone, plants deficient in N and P, regardless of clone, were more resistant to infection than controls receiving N, P and K, but plants deficient in C showed a consistent increase in susceptibility to infection.

Suzuki, K., and Chiba, O. 1973. STUDIES ON THE SUS- CEPTIBILITY TO POPLAR LEAF RUST INFLUENCED BY DIFFERENT NUTRIENT CONDITIONS (II). EFFECT OF CHANGES IN SUGAR LEVEL IN LEAVES. Journal of the Japanese Forestry Society 55 (3): 105-111. [E.jap., 25 ref.]

Suzuki, K., and Chiba, O. 1974. STUDIES ON THE SUS- CEPTIBILITY TO POPLAR LEAF RUST INFLUENCED BY DIFFERENT NUTRIENT CONDITIONS (III). CHANGES IN FREE AMINO ACID CONTENTS. Journal of the Japanese Forestry Society 56 (7): 235-238. [E.jap., 13 ref.]
These results suggest that under conditions of nutrient deficiency, the change in amino-acid metabolism that occurs with rust development is specific to the nutrient supply available.

Szilagyi, L. 1968. [THE MORTALITY OF CUTTINGS INFECTED WITH DOTHICHIZA.] Erdesz. Kutatas., Budapest 64 (1/3): 261-9. [4 refs. [Hu.hu.ru.g.].]
Studies on Populus 'Serotina', P. 'Marilandica', P. 'Robusta' and P. nigra indicated that the incidence of infection and mortality of cuttings decreased with increasing height of the cutting on the shoot. The top one-third was usually free from infection. Intensity of infection on shoots increased with increasing rate of diameter growth of shoots.

Taconis, P. J. 1964. [CONTROL OF LEAF–SPOT DISEASE CAUSED BY MARSSONINA SPP. ON POPLARS.] Verslagen en Mededelingen, Plantenziektenkundige Dienst te Wageningen No. 141, (183-4). [Du.e.] I.M.I.

Taconis, P. J. 1965. [THE CONTROL OF PREMATURE LEAF-FALL IN POPLARS.] Populier, Wageningen 2 (2): 4-5. [Du.du.]
Describes the damage caused by Marssonina and Melampsora spp., lists susceptible species and cultivars, and discusses season and means of control.

Taconis, P. J. 1970. [THE CONTROL OF SOME FOLIAGE DISEASES OF POPLARS.] Populier 7 (3): 46-7. [Du.]
Discusses (with illustrations) the damage caused by Taphrina populina, Marssonina spp. and Melampsora spp., indicates the degree of resistance of some Poplar clones, and recommends chemical control measures.

Taris, B. 1965. [THE VIABILITY OF UREDOSPORES OF MELAMPSORA SPP., RUSTS OF CULTIVATED POPLARS.] C.R. Acad. Agric. France 51 (4): 259-62. [F.] A.P.B.
In laboratory experiments with uredospores from Populus X 'canadensis' cultivars, the uredospores germinated readily from the beginning of April to mid-June. Spores tested 245 days after collection gave 4-8% germination after 72 hr. It is possible, therefore, that primary infections take place in the spring after spore formation.

Taris, B. 1966. [THE BEHAVIOUR OF DOTHICHIZA POPULEA AND CYTOSPORA CHRYSOSPERMA ON TISSUE CULTURES OF POPULUS SPP.] C.R. Acad. Sci., Paris 262D (22): 2347-9. [5 refs. [F.f.] O.R.S.]
The two fungi, although they may be saprophytic in the field, killed living tissues of Poplar species in vitro.

Taris, B. 1966. [THE MAINTENANCE OF PATHOGENICITY BY UREDOSPORES OF MELAMPSORA SP., A RUST OF CULTIVATED POPLARS.] C.R. Acad. Sci., Paris 262D (8): 882-5. 3 refs. [F.f.] O.R.S.
Leaves of Populus nigra and P. X 'canadensis' cultivars carrying uredospores were collected in Sept. 1964 and stored until June 1965. Exposure of leaves of P. X 'canadensis' cv. 'I-214' to this material showed that the uredospores had maintained their viability and pathogenicity for at least 10 months.

Taris, B. 1968. [RUSTS OF POPLAR OBSERVED IN FRANCE.] Ann. Epiphy. 19 (1): 5-54. [43 refs. [F.f.e.] E.M.B.]

Taris, B. 1969. [A STUDY OF TAPHRINA AUREA ON POPLARS.] Bull. Serv. Cult. Etud. Peuplier et Saule (59-154). [F., 115 refs.]

Taris, B. 1972. [DEVELOPMENT AND INTENSITY OF ATTACKS IN 1972 BY SOME LEAF DISEASES ON TEN [POPLAR] CULTIVARS WIDELY DISTRIBUTED IN FRANCE.] Bulletin du Service de Culture et d'Etudes du Peuplier et du Saule (18-26). [F.]
Gives results of a survey of damage done in SW France by Venturia tremulae, V. populina, Septotinia podophyllina, Taphrina aurea, Marssonia brunnea, Melampsora larici-populina, M. allii-populina and Septoria populi.

Taris, B., and Avenard, J. C. 1969. [THE DEVELOPMENT IN SPRING OF ATTACKS BY TAPHRINA AUREA AND T. DE-

FORMANS ON YOUNG LEAF CLUSTERS OF POPLARS AND PRUNUS PERSICA.] C.R. Acad. Sci., Paris 268D (25): 3078-81. [2 refs., [F.f.] O.R.S.]
The two fungi develop differently. T. aurea on Populus 'Regenerata' and P. 'Serotina de Champagne' tended to attack the first four leaves to emerge, whereas T. deformans on Peach attacked the third leaf and those emerging thereafter.

Taris, B., and Avenard, J. -C. 1969. [QUANTITATIVE MODIFICATIONS IN SOME GROWTH SUBSTANCES IN LEAF PARENCHYMA OF PRUNUS PERSICA AND POPULUS X REGENERATA ATTACKED BY TAPHRINA DEFORMANS AND T. AUREA.] C. R. Acad. Sci., Paris 268D (7): 1069-72. [3 refs., [F.f.] O.R.S.]
Those for P. 'Regenerata' attacked by T. aurea show that healthy leaves have a somewhat higher content of IAA than damaged ones.

Tomilin, B. A. 1969. SPECIES OF THE GENUS MYCOSPHAERELLA FOUND ON POPLAR. Transl. Dep. Fish. For. Can. No. OOFF-73, pp. 15. [5 refs. Transl. from Novosti Sistematiki Nizsih Rastenij, Botaniceskij Institut, Akademija Nauk SSSR 1967. pp. 178-87. Russ. Limited distribution.]

Torres Juan, J. 1970. [NEW SPRING DEFOLIATION OF POPLARS.] Bol. Serv. Plagas For. 13 (25): 47-9. [Span.e., 1 ref.]
Damage to foliage of Poplars (particularly those of Sect. Aigeiros) by Venturia populina has recently increased in Spain. Short notes are given on the fungus, its distribution, hosts, type of damage, etc.

Torres Juan, J., Navarrete, M. A., and Tamayo, T. 1973. [THE USE OF NATIVE HARDWOODS FOR THE PRODUCTION OF EDIBLE FUNGI. I.] Madrid, Spain, Instituto Nacional de Investigaciones Agrarias, 60 pp. [Es.e., 3 ref.]

Turkoglu, K., and Erkal, U. 1968. [CONTROL OF SEPTORIA [MYCOSPHAERELLA] POPULICOLA ON POPLAR IN CENTRAL ANATOLIA.] Bitki Koruma Bulteni, Ankara 8 (3): 181-93. [4 refs. [Turk.turk.f.] L.T.P.]
Study of the saprophytic stage of the fungus in dead leaves showed that chemical control measures should begin when the young leaves attain a length of 1 cm. Spraying should then be carried out at intervals of) one week, for two more applications.

Urosevic, B. 1966. [POPLAR CANKER CAUSED BY THE BACTERIUM ERWINIA CANCEROGENA SP. NOV.] Lesn. Cas., Praha 12 (6): 493-505 + 12 photos. [33 refs. [Cz.cz.ru.g.f.e.e.] 1 tbl.]

Urosevic, B. 1967. WEEPING NECROSES OF FOREST TREES FOUND ON THE TERRITORY OF CZECHOSLOVAKIA. Proc. 14th Congr. Int. Union For. Res. Organ., Munich 1967 Pt. V, Sect. 24, (485-93). [18 refs. [E.e.].]
Summarizes research on this desease (found on Birch, Beech, Poplar, Oak, Alder, etc.) and concludes that the pathogen is probably a bacterium close to Erwinia cancerogena, usually associated with Pseudomonas syringae.

Urosevic, B. 1968. [ETIOLOGY OF BROWN SLIME FLUX OF POPLAR AND BIRCH.] Prace Vyzkum. Ust. Lesn. Hosp. Mysl., Zbraslav-Strnady No. 36, (101-17). [27 refs. [Cz.cz.ru.e.ru.e.].]
Describes further inoculation tests which have confirmed the author's assumption that the disease is of bacterial origin, caused by the joint pathogenic effect of Erwinia and Pseudomonas spp.

Urosevic, B. 1969. RESISTANCE AND SUSCEPTIBILITY OF EUROPEAN POPLAR CULTIVARS TO SOME IMPORTANT BACTERIAL DISEASES. Commum. Inst. For. Csl. 6, (127-40). [E.ru., 7 refs.]
Tabulates and discusses results for some 50 cultivars from inoculation experiments with Aplanobacterium populi and Erwinia cancerogena.

Urosevic, B. 1973. NEW AND LITTLE KNOWN DISEASES OF LEAVES AND GREEN SPROUTS OF POPLARS FOUND IN CZECHOSLOVAKIA. Communicationes Instituti Forestalis Cechosloveniae 8, 159-173. [E.ru., 27 ref.]

Veldeman, R. 1966. [MARSSONINA DISEASE OF POPLARS.] Meded. Rijksfac. Landbouww. Gent 31 (3): 907-14. [Du.du.f.e.g.] [1 photo.]

Veldeman, R. 1972. [THE PRESENCE OF ARMILLARIA .MELLA. ON POPULUS.] Ghent Rijksfac Landbouwetensch Meded. 37 (2): 574-586. [E.sum.]

Veldeman, R. 1973. [ARMILLARIA MELLEA ON POPLAR.] Bulletin de la Societe Royale Forestiere de Belgique 80 (3): 136-140 + 1 pl. [Nl.F.]
A note on the host/parasite relations, with practical recommendations on ways of preventing or controlling damage by A. mellea on Poplar.

Veldeman, R. 1974. [DO THE DEATHS RECORDED AMONG POPLARS CONSTITUTE A NEW MENACE?] Bulletin de la Societe Royale Forestiere de Belgique 81 (4): 207-218. [F.Nl.]
Discusses the widespread occurrence of partial or total death of Poplars in some parts of Belgium in 1964 and again in 1973, and attributes it to a new fungus disease caused by Chalaropsis populi, which causes bark necroses on the stem and branches.

Verona, O., and Magnani, G. 1972. [ACTION OF CALCIUM CYANAMIDE ON MARSSONINA BRUNNEA INFECTION ON POPLAR.] Agricoltura Italiana 72 (1): 13-17. [It.] From Review of Plant Pathology 52, 3842.
In nursery and field trials [in Italy], M. brunnea infection was controlled, particularly on susceptible Poplar clones, by adding relatively large amounts of Ca cyanamide to the soil.

Viart, M. 1966. [THE PRESENT STATE OF KNOWLEDGE ON BACTERIAL CANKER OF POPLAR. [CAUSED BY APLANOBACTERIUM POPULI].] Bull. Serv. Cult. Etud. Peuplier et Saule, Paris (1/2), (9-44). [F.]

Vujic, P. 1967. [MARSSONINA BRUNNEA.] Topola, Beograd 11 (61/64): 199-204. [9 refs. [Serb.serb.f.].]
Discusses its distribution in Jugoslavia, and the extent of the damage, the resistance of various cultivars of Populus X 'canadensis', and the effect of temperature, air humidity and soil on the spread of the disease.

Walker, J., Hartigan, D., and Bertus, A. L. 1974. POPLAR RUSTS IN AUSTRALIA WITH COMMENTS ON POTENTIAL CONIFER RUSTS. Eur. J. For. Pathol. 4 (2): 100-118. [Map. Ref.]

Weisgerber, H. 1969. Untersuchungen uber Pollaccia radiosa, den Erreger der Triebspitzenkrankheit an Pappeln der Section Leuce Duby. Hamburg 20 S., [8 Abb., 3 graph. Darst., 43 Lit.Ang.E.Zsfg.] S. A. aus: Phytopathol. -Z., Hamburg 66 S. 50-68.

Whitbread, R. 1967. BACTERIAL CANKER OF POPLARS IN BRITAIN. I. THE CAUSE OF THE DISEASE AND THE ROLE OF LEAF-SCARS IN INFECTION. Ann. appl. Biol. 59 (1): 123-31. [9 refs. O.R.E.]
Bacterial canker and dieback of Poplars in Britain was shown to be caused by Aplanobacterium populi; leaf scars are the main avenues for infection, but their infectibility declines rapidly during October.

Wolterson, J. F. 1967. [NEW POPLAR CLONES AND BACTERIAL CANKER.] Ned. Bosb. Tijdschr. 39 (8): 398. [3 refs. [Du.e.].]
Discusses briefly the possible susceptibility of new cultivars commercially available in the Netherlands ('Dorskamp', 'Flevo' and the 3 hybrid Balsam Poplars 'Geneva', 'Oxford' and 'Androscoggin') and recommends that they should be planted only on a small scale at first.

Yakovleva, L. M. 1973. [PSEUDOMONAS CERASI GRIFFIN – CAUSAL AGENT OF POPLAR LEAF BLIGHT.] Mikrobiologichnii Zhurnal 35 (4): 438-443. [Uk.ru.e.] From Review of Plant Pathology 53, 1096.
Describes the biochemical, cultural, morphological and pathogenic properties of this bacterium, isolated from Poplar in the Ukraine.

Yakovieva, L. M., and Gvozdyak, R. I. 1973. [PSEUDOMONAS CERASI GRIFFIN AND P. SYRINGAE VAN HALL F. POPULI SABET & DOWSON, THE PATHOGENS OF POPLAR CANKER DISEASE.] Mikrobiologichnii Zhurnal 35 (5): 570-575 [Uk.ru.e.] From Review of Plant Pathology 53, 1965.
Describes symptoms of the disease of Populus spp. caused by P. cerasi [P. syringae] and P. syringae f. populi [P. syringae f. sp. populea] in the Ukraine.

'i, C. K., and La, Y. J. 1970. RELATIVE POPLAR CANKER DISEASED BY CYTOSPORA SP. RESISTANCE OF NATIVE AND NTRODUCED POPLAR CLONES. Seoul (Korea) For. Res. Inst. es. Rep. 17: 61-64. [Kor.]

alasky, H. 1974. KEISSLERIELLA EMERGENS, A PERFECT TATE OF DIPLODIA TUMEFACIENS IN ROOTS OF POPLAR. an. J. Bot. 52 (1): 11-13.

alasky, H., and Fenn, O. K. 1965. INOCULATION TESTS WITH IPLODIA TUMEFACIENS (SHEAR) ZALASKY. Bi-m. Progr. ep. Dep. For. Can. 21 (6): 3.

asev, B., and Canova, P. 1969. [THE RUST MELAMPSORA LLII-POPULINA IN BULGARIA, AND ITS CONTROL.] orskostop. Nauka, Sofija 6 (5): 65-75. [Bulg.ru.e., 21 refs.]
prays of Bordeaux mixture give control in Poplar nurseries and oung plantations. Populus 'I-214', P. 'Bg.-4', P. X marilandica, P. Vernirubens'. and P. alba X P. tremula are resistant or fairly esistant to M. allii-populina, though the last-named hybrid is highly usceptible to M. pinitorqua.

iller, W. G. 1964. HOST RANGES AND TAXONOMY OF THE OPLAR RUSTS OF THE WORLD. Bi-m. Progr. Rep. For. Ent. ath. Br. Dep. For. Can. 20 (2): 3.
Briefly describes a programme of international research, designed to est economically important conifers for their susceptibility to Melampsora rusts occuring in Italy, Japan, E. Argentina, and W. Canada, and to review the taxonomy, host ranges, and geographical listribution of Poplar rusts on a worldwide basis.

Zycha, H. 1965. [MARSSONINA DISEASE, A NEW THREAT TO POPLARS.] Allg. Forstzeitschr. 20 (27): 422-3. [G.] 2 photos.
Briefly summarizes symptoms, species of pathogen, injuries, distribution, especially in W. Germany (where Black and White Poplars in the Rhineland and on the N. German coasts are affected), effect of the weather, susceptibility of species and cultivars of the sections Aigeiros and Leuce, and control.

Zycha, H. 1965. [MARSSONINA DISEASE OF POPLARS.] Forstwiss. Cbl. 84 (7/8): 254-9. 21 refs. [G.g.]
Reviews and summarizes the present state of knowledge of the conditions that promote the disease, its symptoms as caused by different species of Marssonina, the Poplars that are known to be susceptible, and the distribution of the disease in various countries.

Zycha, H., and Frohlich, H. J. 1966. [THE OCCURRENCE OF THE MARSSONINA DISEASE ON POPLAR SPECIES AND CULTIVARS IN W. GERMANY IN 1965.] Holzzucht, Reinbek 20 (1/2): 1-8. [21 refs. [G.g.f.].]
Of Black Poplar hybrids, the cultivars 'Robusta', 'Brabantica', 'Serotina', 'Dromling' and 'Grandis' were least affected. Infection was highest on 'Marilandica', 'Forndorf', and 'Virginiana de Frignicourt'. Clones of Populus nigra and P. deltoides were more resistant than hybrids. Balsam Poplars and their hybrids were fairly resistant. No infection was observed on P. trichocarpa or on Poplars of the section Leuce.

Zycha, H., and Weisgerber, H. 1967. [THE SUSCEPTIBILITY OF SPECIES AND HYBRIDS OF POPULUS SECT. LEUCE TO ATTACK BY POLLACCIA RADIOSA.] Proc. 14th Congr. Int. Union For. Res. Organ., Munich 1967 Pt. III, Sect. 22, (852-60). [G.]

444 VIRUS DISEASES

Berg, T. M. 1964. STUDIES ON POPLAR MOSAIC VIRUS AND ITS RELATION TO THE HOST. Meded. Landb-Hogesch. Wageningen 64 (11), pp. [iii] + 59 + 1 tbl., 20 photos. 69 refs. [E.e.du.]
A survey of clones at Wageningen and many others (listed in an appendix) showed that most clones of section Aigeiros were susceptible (only 3 of 90 Populus C 'canadensis' clones were not), all developing an asteroid leaf-spot, except P. 'deltoides angulara' which showed a diffuse leaf-spot and necrotic symptoms on veins and petioles and, in severe cases, twig swellings.

Bertranet, Y., and Taris, B. 1971. [THE PRESENT STATE OF KNOWLEDGE OF THE POPLAR MOSAIC VIRUS, AND ITS INCIDENCE IN CULTIVATED POPLARS.] Bull. Serv. Cult. Etud. Peuplier et Saule (55-64). [F., 22 ref.]

Biddle, P. G. 1968. A STUDY OF VIRUS DISEASES OF FOREST TREES. Thesis, Commonwealth Forestry Institute, Oxford. pp. [xiv] + 233. [66 refs. Smry. 43 photos. 19 dgms. & gphs. 45 tbls.]

Biddle, P. G. 1969. FOREST PATHOLOGY: (B) VIROLOGY. Extr. from Rep. Commonw. For. Inst., Oxf. 1967/68, (30-1).

Biddle, P. G., and Tinsley, T. W. 1967. THE POTENTIAL IMPORTANCE OF VIRUS DISEASES IN FOREST TREES. Commonwealth Forestry Institute, Oxford. pp. 4 [14 refs. (Pap. 9th Commonw. For. Conf., New Delhi 1968).]

Biddle, P. G., and Tinsley, T. W. 1971. POPLAR MOSAIC VIRUS. CMI/AAB Descr. Plant Viruses No. 75, pp. [3].
The natural hosts of this virus are Poplars of the sections Aigeiros and Tacamahaca throughout their geographical range, but species in 20 dicotyledenous families can be infected by inoculation.

Biddle, P. G., and Tinsley, T. W. 1971. POPLAR MOSAIC VIRUS IN GREAT BRITAIN. New Phytol. 70 (1): 61-6 + 1 plate. [9 refs. O.R.S.]
Discusses host range and symptoms, and the in vitro properties of the virus.

Blattny, C., et al. 1965. [FURTHER INFORMATION ON POPLAR MOSAIC.] Lesn. Cas., Praha 11 (7): 637-48. [10 refs. [Cz.cz.ru.e.g.f.].]
Lists species attacked in Czechoslovakia and discusses results of greenhouse and field studies.

Commonw. For. Inst. 1968. FOREST PATHOLOGY: (B) VIROLOGY. Extr. from Rep. Commonw. For. Inst., Oxf. 1966/67, (25-6).
Experiments have shown that, in addition to a reduction in volume increment, the Poplar mosaic also causes a considerable reduction in wood density. This reduction cannot be related to variation in the ratio of cell wall to cell lumen or to variations in the % volume of different types of cell.

Cooper, J. I. 1974. VIRUS DISEASES OF TREES. In Report on Forest Research, Forestry Commission, UK. 66 [E.]
A note reporting the detection of nematode-transmitted viruses with polyhedral particles (NEPO) in Fraxinus excelsior and four other genera of the Oleaceae, Betula pendula [B. verrucosa] and Populus X euramericana [P. X canadensis aggr.].

Hart, S. G. P. 1965. PURIFICATION OF POPLAR MOSAIC VIRUS. Special Subject, Commonwealth Forestry Institute, Oxford, pp. 42. [63 refs., Smry.]

Meiden, H. A. van der. 1964. [VIRUS WITH POPLAR.] Nederlands Bosbouw Tijdschrift 36 (9): 269-275. [Du.e.]

Milinko, I., and Schmelzer, K. 1966. [THE OCCURRENCE OF POPLAR MOSAIC IN HUNGARY.] Erdo 15 (4): 172-5. [Hu.ru.g.]
Reports observations of the disease in Hungary in 1964. Susceptibility of clones of hybrid Black Poplars varied. P. X serotina was the most susceptible; 'I-214' was resistant but not immune.

Morand, J.-C. 1971. [POPLAR MOSAIC VIRUS: SELECTION FOR HEALTHY CLONES.] Bull. Serv. Cult. Etud. Peuplier et Saule (65-9). [F.]
Outlines the procedure to be followed in the selection of resistant clones.

Navratil, S. 1967. [PHYSIOLOGICAL CHANGES IN THE HOST PLANT CAUSED BY POPLAR VIRUS MOSAIC.] Lesn. Cas., Praha 13 (12): 1105-12. [21 refs. [Cz.cz.ru.e.]
Presents and discusses the results of vegetative propagation trials carried out with 9 cultivars, illustrating the decrease in the rooting capacity of stem cuttings caused by infection of the parent tree in the previous growing season.

Schmelzer, K. 1964. [NOTES ON THE MOSAIC DISEASE OF POPLAR.] Arch. Forstw. 13 (8): 787-98. 15 refs. [G.g.ru.e.]
The symptoms of this leaf mosaic, hitherto overlooked, but now reported from 6 European countries, are described and distinguished from those of injury by mites and from a genetical variegation.

Schmelzer, K. 1966. [STUDIES OF VIRUSES ON ORNAMENTAL AND WILD WOODY SPECIES. 5. VIRUS DISEASES OF POPULUS AND SAMBUCUS.] Phytopath. Z. 55 (4): 317-51. [31

refs. [G.g.e.] O.R.S.]
Describes the Poplar mosaic virus, a ring-spot virus of Sambucus racemosa and the viruses isolated from S. nigra suffering from yellow-net disease, and lists other hosts.

Siwecki, R. 1966. [OBSERVATIONS ON POPLAR MOSAIC.] Sylwan 110 (2); 91-6. [10 refs. [Pol.ru.e.]

45 DAMAGE BY ANIMALS

451 MAMMALS

Almasan, H. 1966. [INJURY TO 'EURAMERICAN' POPLAR PLANTATIONS BY RED DEER.] Rev. Padurilor 81 (9): 509-10. [2 refs. [Ro.].]
Observations in two plantations of hybrid Poplars, (1) pure and (2) interplanted with rows of Cornus sanguinea, showed that deer browsing was more extensive in (1) than in (2) (90% of trees injured vs. 61%), and the individual injuries were more severe.

Arru, G. M. 1974. [DAMAGE TO POPLARS BY HARES, AND MEANS OF PROTECTION.] Cellulosa e Carta 25 (2): 37-46. [It.f.e.de., 5 ref.]

Baskin, L. M. 1965. [THE FOOD OF CERVUS ELAPHUS.] Zool. Z., Moskva 44 (3): 465-9. 2 refs. [Ru.ru.e.] B.A.P.

Edwards, W. R. N. 1974. PALATABILITY OF POPULUS SPP. TO OPOSSUM. NWASCO Res. Rep. 11 pp.

Klinkspoor, H. 1966. [DAMAGE TO POPLARS BY MAMMALS.] Populier, Wageningen 3 (3): 45-7. [Du.]
Discusses the nature and extent of damage by deer, rabbits and hares in the Netherlands, and various mechanical and chemical methods of protecting plantations and individual trees.

Henry, D. B., and Bookhout, T. A. 1970. UTILIZATION OF WOODY PLANTS BY BEAVERS IN NORTHEASTERN OHIO. Ohio J. Sci. 70 (2): 123-7. [7 refs. N.L.L.]
Preferred foods were: Populus sp., Alnus sp., Ostrya virginiana, Prunus serotina, Salix sp., Cornus sp., and Quercus spp.

Koenders, J. W. 1974. [DAMAGE BY SMALL RODENTS.] Populier 11 (2): 38-39. [Nl., 4 ref.]

Kulicke, H. 1967. [THE IMPORTANCE OF ARVICOLA TERRESTRIS IN THE FORESTS OF E. GERMANY.] Arch. Forstw. 16 (6/9): 797-801. [G.]
Gives information on the occurrence and intensity of outbreaks of this vole in E. Germany during 1959-66, the type of habitat favouring population increases, and the tree species attacked.

Kulicke, H., and Ritter, G. 1968. [APPRAISING THE RESULTS OF CONTROL MEASURES AGAINST ARVICOLA TERRESTRIS BY USING LABELLED BAIT.] Arch. PflSch., Berl. 4 (3): 179-85. [11 refs. [G.g.ru.e.].]

Markham, K. R. 1971. A CHEMOTAXONOMIC APPROACH TO THE SELECTION OF OPOSSUM RESISTANT WILLOWS AND POPLARS FOR USE IN SOIL CONSERVATION. N. Z. J. Agric. Sci. 14 (1): 179-86.

Sanchez, A. 1967. [RODENT INJURY TO POPLARS AND AN EXPERIMENT IN ITS CONTROL.] Bol. Serv. Plagas For., Madrid 10 (19): 63-8. [Span.span.e.]
A study of injury by water-voles, Arvicola sapidus, in a Poplar stand at Requena, Valencia, showed the beneficial effects of keeping down the grass cover.

Toth, J. 1969. [PREVENTION OF GAME DAMAGE IN PLANTATIONS IN THE LOWER DANUBE BASIN.] Erdo 18 (1): 12-8. [6 refs. [Hu.ru.g.].]

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Bowersox, T. W. 1973. SMALL MAMMALS CAN DAMAGE YOUNG HYBRID POPLAR PLANTATIONS. Tree Planters' Notes 24 (1): 10. [E.]

Guldemond, J. L., and Kolster, H. W. 1967. [PROTECTION OF POPLAR AGAINST DAMAGE BY GAME.] Populier 4 (2): 25-26. [Du.]

453 INSECTS

Anonymous. 1964. [INSECT PESTS.] Meded. Inst. Toegep. Biol Onderz. Nat. No. 65, (33-7, 54). [Du.e.]

Anonymous. 1965. [THE USE OF CIDIAL TO CONTROL CRYPTORRHYNCHUS LAPATHI.] Contributi Instituto di Ricerche Agrarie Montecatini, Milano 7, (7-10). 2 refs. [It.it.f.e.g.] I.I.E.
Cidial oil, in particular, was nearly as effective as parathion. Cidial-50 emulsion was slightly less so at the same dosage. There was no phytotoxic effect.

Anonymous. 1967. THE PROTECTION OF FORESTS FROM PESTS AND DISEASES. Transl. Dep. For. Can. No. 145, pp. 54. [Transl. by G. J. Harder from Zascita lesnyh nasazdenijot vreditelej i boleznej. Lesnoe Hozjajstvo, Moscow. 1965. pp. 2-36. [Ru.] Limited distribution.]
Comprises papers by members of the staff of the All-Union Research Institute for Forestry and Forestry Mechanization (VNILM) Inc. The large Poplar and Willow borer and the measures to control it (N.P. Pavlinov) [a study of the biology and control of Saperda carcharias in the Moscow region].

Abrahamson, L. P., and McCracken, F. I. 1971. INSECT AND DISEASE PESTS OF SOUTHERN HARDWOODS. Symp. Southeast. Hardwoods Proc. 1971: 80-89. USDA Forest Serv. State & Priv. Forest., Atlanta, Ga.

Adeli, E. 1971. [DAMAGE BY NYCTEOLA ASIATICA ON POPLARS IN IRAN.] Anz. Schadlingsk. 44 (8): 119-20. [De.e., 5 ref.]

Adeli, E., and Lotfian, H. 1967. [LEPIDOPTERA – NOCTUIDAE] Bulletin, Faculty of Forestry, University of Teheran No. 5, pp. 27 + 10. [9 refs. [Pers.e.f.].]
Covers the distribution (E. Europe and W. Asia), life history, hosts (several species and varieties of Poplar), and control of this defoliator. Populus deltoides appears to be relatively immune to attack.

Agenjo, R. 1964. [SPANISH LEPIDOPTERA INJURIOUS TO FOREST NURSERIES AND YOUNG PLANTATIONS.] Bol. Serv. Plagas For., Madrid 7 (13): 38-41. [Span.span.e.]

Agenjo, R. 1967. LYCIA HIRTARIA, A GEOMETRID NOT PREVIOUSLY RECORDED FROM SPANISH POPLARS. Graellsia, Madrid 23, (207-14). [Span. 11 refs. From abstr. in Rev. appl. Ent. 1970 58 A (11), (No. 3417).]
Records the first observation on Poplars in Spain – near Madrid in 1965 – of L. hirtaria, which occurs on various trees and shrubs in several Spanish provinces.

Aibasov, Kh. A. 1974. [COLEOPTERA DAMAGING POPLAR IN SE KAZAKHSTAN.] Trudy Instituta Zoologii, Akademiya Nauk Kazakhskoi SSR 35 (143-157). [Ru. 21 ref. title in Review of Applied Entomology, A 63, 2886.]

Aibasov, Kh. A. 1974. LEAFHOPPERS AND SCALE INSECTS (HOM., CICADINEA, COCCINEA) DAMAGING POPLAR [IN KAZAKHSTAN]. Trudy Instituta Zoologii, Akademiya Nauk Kazakhskoi SSR 35 (126-132). [Ru. 13 ref. From title in Review of Applied Entomology, A 63, 2885.]

Akanbi, M. O. 1973. THE BIOLOGY, ECOLOGY, AND CONTROL OF PHALANTA PHALANT[H]A DRURY (LEPIDOPTERA: NYMPHALIDAE), A DEFOLIATOR OF POPULUS SPP. IN NIGERIA. Research Paper (Forest Series), Federal Department of Forest Research. Nigeria No. 5, 26 pp. [E., 1 ref.]

Allen, A. A. 1973. A NOTE ON FOODPLANTS IN THE GENUS CHALCOIDES (COL., CHRYSOMELIDAE). Entomologist's Monthly Magazine 108 (1301/1303) 213, [E.]
A note on the feeding habits of five species of Chalcoides on Poplars and Willows in SE England, indicating that significant preferences exist.

Alleyne, E. H., and Morrison, F. O. 1974. PEMPHIGUS SPIROTHECAE (HOMOPTERA: APHIDOIDEA), AN APHID WHICH CAUSES SPIRAL GALLS ON POPLAR IN QUEBEC. Can. Entomol. 106 (11): 1229-1231. Ref.

Amiressami, M. 1973. [EFFECT OF INSECTICIDES ON THE NEUROSECRETORY CELLS OF PEMPHIGUS BURSARIUS L. (APHIDINA). Anz. Schadlingskd. Pflanzenschutz. 46 (9): 132-137. Ref. [G.e.]

Amiressami, M. 1973. [A HISTOLOGICAL EXAMINATION OF THE CORPORA ALLATA AND CORPORA CARDIACA OF VARIOUS GENERATIONS OF PEMPHIGUS BURSARIUS L. (APHIDINA) FOR THE EFFECT OF INSECTICIDES.] Zool. Jahrb., Abt. Anat. Ontog. Tiere. 91 (2): 242-256. [G.e.]

Andrews, T. L. 1974. RESMETHRIN RESIDUES IN FOLIAGE AFTER AERIAL APPLICATION. Pesticides Monitoring Journal 8 (1) 50-52. [E., 5 ref.]
Describes a method for detecting small quantities (0.06-0.25 p.p.m.) of the insecticide resmethrin by thin-layer chromatography.

Arru, G. 1969. OBSERVATIONS ON ENTOMOLOGICAL PROBLEMS OF POPLAR IN CANADA AND THE UNITED STATES. Cellulosa e Carta 20 (3): 4-7. [It.]

Arru, G., and Lapietra, G. 1969. SUSCEPTIBILITY OF POPLAR CLONES 'I-214' AND 'I-488' TO THE ATTACKS OF SAPERDA CARCHARIAS L. Cellulosa e Carta 20 (3): 14-20. [It.]

Arru, G. M. 1965. [A TENTHREDINID MINER HARMFUL TO POPLARS: HETERARTHRUS (– PHYLLOSTOMA) OCHROPODUS KLUG.] Cellulosa e Carta 16 (11): 8-10. 1 ref. [It.f.e.g.]
Satisfactory control of the fourth instar can be obtained by spraying infested trees with malathion (70 g. active principle per hectolitre water).

Arru, G. M. 1966. [PYGAERA ANASTOMOSIS, A LEPIDOPTEROUS DEFOLIATOR OF POPLARS.] Cellulosa e Carta 17 (10): 27-32. [It.it.f.e.g.]
The biology (4 generations per year) of P. anastomosis in N. Italy is described.

Arru, G. M. 1967. RESISTANCE TO INSECTS IN POPLARS GROWN IN ITALY. Proc. 14th Congr. Int. Union For. Res. Organ., Munich 1967 Pt. III, Sect. 22, (861-6). [11 refs. [E.e.].]

Arru, G. M. 1970. THE POPLAR STEM WEEVIL. Inform. Fitopatol. 20 (8): 12-14. [It.]

Arru, G. M. 1973. [INSECTICIDE TREATMENTS AGAINST THE NEWLY HATCHED LARVAE OF SAPERDA CARCHARIAS (COL., CERAMBYCIDAE) AND THE EFFECTS ON THE EGG PARASITE EUDERUS CAUDATUS (CHALCIDOIDEA EULOPHIDAE).] Bollettino di Zoologia Agraria e di Bachicoltura 10 (1): 11-19. [It.e., 5 ref.] From Review of Applied Entomology; A 63, 1077.
The mortality of E. caudatus was significantly higher on treated trees (37-64%) than on untreated trees (0-15%).

Arru, G. M. 1974. [METHOD FOR THE EVALUATION OF POPLAR RESISTANCE TO WOOLY APHID. (PHLOEOMYZUS PASSERINII SIGN.).] Cellulosa e Carta 25 (5): 45-49. [It.e.]

Arru, G. M., and Lapieira, G. 1971. [EXPERIMENTS ON PEST CONTROL IN POPLAR NURSERIES WITH GRANULAR SYSTEMIC INSECTICIDES APPLIED TO THE SOIL.] Cellulosa e Carta 22 (7): 36-43. [It.f.e.de., 10 ref.]

Arru, G. M., and Lapietra, G. 1974. ON THE USE OF SYSTEMIC INSECTICIDES AGAINST INJURIOUS INSECTS TO POPLAR IN ITALY. Cellulosa e Carta 25 (5): 50-60. Ref. [It.e.]

Astiaso, J. F. 1966. [THE IMPORTANCE OF MELANOPHILA PICTA AND ITS CONTROL.] Bol. Serv. Plagas For., Madrid 9 (18): 123-5. [Span.span.e.]
Spraying the stems up to a height of 2 m. with 0·5% dieldrin gave the most effective control and should be done 2 weeks after the first flight of adults is observed.

Barter, G. W. 1965. SURVIVAL AND DEVELOPMENT OF THE BRONZE POPLAR BORER AGRILUS LIRAGUS BARTER AND BROWN (COLEOPTERA: BUPRESTIDAE). Repr. from Canad. Ent. 97 (10): 1063-8. 12 refs.

Bellis, E. de. 1964. [CONTROL OF SAPERDA CARCHARIAS ON POPLAR BY THE USE OF EQUIPMENT DESIGNED AT THE CENTRO DI DIFESA FITOSANITARIA.] Cellulosa e Carta 15 (3): 25-7. [It.it.f.e.g.].]
Good control was obtained by spraying the stems to a height of 4 mi immediately after all eggs had hatched, with 50% parathion at 60 g./hectolitre of water.

Bellis, E. de. 1969. [THE BIOLOGY AND BEHAVIOUR OF SAPERDA CARCHARIAS (COLEOPTERA-CERAMBYCIDAE).] Pubbl. Cent. Sper. Agric. For. 10 (4): 249-303 + 22 plates. [It.e., 3 pp. of refs.]

Bellis, E. de, and Cavalcaselle, B. 1964. [FURTHER INVESTIGATIONS ON THE CONTROL OF NEWLY HATCHED LARVAE OF SAPERDA CARCHARIAS BY PHOSPHORIC ESTERS.] Pubbl. Cent. Sper. Agric. For., Roma 7, (81-8 + 1 plate). 10 refs. [It.it.e.e.]
Bopardoil, Phosdrin, and Delfos were all very effective when sprayed on the bark of Poplars, even at the lowest concentrations (250 c.c./100 litres water).

Bellis, E. de., and Cavalcaselle, B. 1965. [CONTRIBUTION TO THE STUDY OF CONTROL MEANS AGAINST PARANTHRENE UNIFORMIS ROTT. PRELIMINARY TRIALS.] 12th Sess. FAO/CIP, Teheran. [F.]

Bellis, E. de., and Cavalcaselle, B. 1966. [PRELIMINARY INVESTIGATION ON THE CHEMICAL CONTROL OF PARANTHRENE TABANIFORMIS (LEPIDOPTERA – AEGERIIDAE).] Pubbl. Cent. Sper. Agric. For., Roma 8, (241-8 + 1 plate). [13 refs. [It.it.e.e.].]

Bellis, E. de., and Cavalcasselle, B. 1966. [CHEMICAL CONTROL TESTS AGAINST PARANTHREOETABANIFORMIS ROTT. ATTACKING POPLARS.] 6th World For. Congr., Madrid.

Bellis, E. de, and Cavalcaselle, B. 1968. [FURTHER TRIALS ON THE CHEMICAL CONTROL OF PARANTHRENE TABANIFORMIS.] Pubbl. Cent. Sper. Agric. For. Roma 9 (4): 283-9 + 1 plate). [16 refs. [It.it.e.].]

Bellis, E. de, and Cavalcaselle, B. 1968. [IMPORTANCE OF DAMAGE TO YOUNG POPLARS BY PARANTHRENE TABANIFORMIS AND GYPSONOMA ACERIANA IN SOME ENCC NURSERIES IN CENTRAL AND SOUTHERN ITALY.] Cellulosa e Carta 19 (1): 29-32. [It.it.f.e.g.]

Bellis, E. de, and Cavalcaselle, B. 1968. [SIMULTANEOUS CHEMICAL CONTROL OF LARVAE OF PARANTHRENE TABANIFORMIS AND OF GYPSONOMA ACERIANA.] Pubbl. Cent. Sper. Agric. For., Roma 10 (1): 73-80 + 2 plates. [16 refs. [It.it.e.e.].]
Three insecticides – Cidial 50, Didifos 50 and Rogor 20L were tested in a Poplar nursery infested with both insects. All gave good control of both insects. Didifos 50 is recommended for heavy infestations.

Brizzi, G. 1965. [THE BIONOMICS OF MELANOPHILA PICTA DECASTIGMA, A PEST OF YOUNG POPLAR PLANTS.] Redia, Firenze 19, (229-38 + 8 photos). [13 refs. [It.it.e.] I.I.E.]
Preliminary tests suggest that it can be controlled by a mixture of 0·2% DDT and 0·2% parathion applied twice, at ca. 20 days' interval, in June. One treatment, immediately after a mass emergence of adults, may suffice.

Campbell, R. W. 1974. RELATIONSHIP BETWEEN OVERSTOREY COMPOSITION AND GYPSY MOTH EGG-MASS DENSITY. USDA Forest Service Research Note, Northeastern Forest Experiment Station No. NE-191, 6 pp. [E., 7 ref.]
The results show that the populations of L. dispar are not closely related to the proportions of favoured food trees.

Cavalcaselle, B. 1966. [CRYPTORRHYNCHUS LAPATHI (COLEOPTERA, CURCULIONIDAE).] Pubbl. Cent. Sper. Agric. For., Roma 8, (135-73 + 10 plates). [74 refs. [It.it.e.e.].]

Cavalcaselle, B. 1967. [THE INFLUENCE OF SOME CLIMATIC FACTORS ON THE EFFECTIVENESS OF TREATMENTS TO CONTROL CRYPTORRHYNCHUS LEPATHI,] Pubbl. Cent. Sper. Agric. For., Roma 9 (3): 181-7. [11 refs. [It.it.e.e.] 3 tbls.]

Cavalcaselle, B. 1968. CONTRIBUTION TO THE KNOWLEDGE OF THE CRYPTORRHYNCHUS LAPATHI L. (COLEOPTERA:

CURCULIONIDAE). Transl. Dep. For. Can. No. 196, pp. 36 + 6 gphs., 10 plates. [74 refs. Transl. from Pubbl. Cent. Sper. Agric. For., Roma No. 8, 1965 (1966), (137-73).

Cavalcaselle, B. 1968. [AN INTERESTING CASE OF ADAPTATION TO DIFFERENT HOSTS BY AN EGG PARASITE.] Entomophaga 13:319-22. [It.e.]

Cavalcaselle, B. 1968. [STAURONEMATUS [PRISTIPHORA] COMPRESSICORNIS (HYMENOPTERA – TENTHREDINIDAE).] Pubbl. Cent. Sper. Agric. For. Roma 9 (4): 235-82 + 10 plates). [58 refs. [It.it.e.].]
An illustrated account of studies near Rome during 1960-66 on the morphology, histology and life cycle of S. compressicornis, the damage (defoliation) it causes to Poplars and Willows – especially Populus nigra, P. alba and P. suaveolens – and its natural and chemical control.

Cavalcaselle, B. 1972. [PILOT EXPERIMENTS FOR THE CONTROL OF INSECT PESTS OF POPLAR IN THE NURSERY BY MEANS OF SYSTEMIC INSECTICIDES IN GRANULAR FORM.] Cellulosa e Carta 23 (7): 17-25. [It.f.e.de., 13 ref.]
The results showed that Thimet 10-Cynamid and Disyton were effective only against two chrysomelid defoliators, Melasoma populi and Plagiodera versicolor; for this reason, and the very high cost of treatment at the doses tested, their use in Poplar nurseries is not advisable.

Cavalcaselle, B. 1972. [ECOLOGY AND LIFE HISTORY OF SOME BUPRESTID PESTS OF POPLAR IN CENTRAL AND SOUTHERN ITALY.] Redia 53, 67-122 + 19 pl. [It.e., 103 ref. OH]

Cavalcaselle, B. 1972. [PRELIMINARY INVESTIGATIONS ON REARING CRYPTORRHYNCHUS LAPATHI L. ON SYNTHETIC MEDIA.] Pubbl. Centro Sper. Agric. For. 11: 85-93. [It.it.e.]

Cavalcaselle, B., Bellis, E. de, and Liani, A. 1964. [THE PENETRATION OF PARATHION-P^{32} INTO POPLAR STEMS.] Pubbl. Cent. Sper. Agric. For., Roma 7, (89-97 + 4 plates). 19 refs. [It.it.e.e.]

Cavalcaselle, B., and Bellis, E. de. 1966. [POSSIBILITIES OF USING CIDIAL TO CONTROL CERTAIN BORERS ATTACKING POPLARS.] Cellulosa e Carta 17 (1): 23-9. 5 refs. [It.it.f.e.g.]
Of six insecticides tested against Cryptorrhynchus lapathi and Saperda carcharias, parathion and Cidial gave best results.

Cavalcaselle, B., and Bellis, E. de. 1967. [THE POSSIBILITIES OF CIDIAL FOR THE CONTROL OF POPLAR BORERS.] Pubbl. Cent. Sper. Agric. For., Roma 9 (3): 155-62 + 5 photos). [15 refs. [It.it.e.e.].]
Tests of Cidial and of parathion, sprayed in springtime on stems in a Poplar plantation, proved highly, and equally, effective against both Cryptorrhynchus lapathi and Saperda carcharias. Cidial, being much less toxic to mammals, is therefore to be preferred.

Cavalcaselle, B., and Bellis, E. de. 1967. [PRELIMINARY EXPERIMENTS ON THE CONTROL OF CRYPTORRHYNCHUS LAPATHI L. BY MEANS OF IONIZING ZINC RADIATIONS.] Proc. 14th Congr. IUFRO, Munich pt. 5, sect. 24: 571-86. [E.e.]

Cavelcaselle, B., and Bellis, E. de. 1968. [COMPARATIVE TRIALS IN CHEMICAL CONTROL OF LARVAE AND ADULTS OF CRYPTORRHYNCHUS LAPATHI.] Pubbl. Cent. Sper. Agric. For., Roma 10 (2): 123-34 + 2 plates). [24 refs. [It.it.e.e.].]
When plantations are accessible in late winter, best control is obtained by spraying Poplars with parathion (150 g. active ingredient/hl.) in Feb. and March to kill the overwintering larvae. Control of adults is best obtained by spraying in Aug. with Gusathion (100 g. a.i./hl.)

Cavalcaselle, B., and Bellis, E. de. 1968. [NYCTEOLA ASIATICA INJURIOUS TO POPLARS IN CENTRAL AND SOUTHERN ITALY.] Cellulosa e Carta 19 (10): 31-6. [It.it.f.e.g.]

Cavalcaselle, B., and Bellis, E. De. 1969. [PRELIMINARY EXPERIMENTS FOR THE CONTROL OF CRYPTORRHYNCHUS LAPATHI L. BY MEANS OF IONIZING RADIATIONS.] Pubbl. Centro Sper. Agric. For. 10:89-101. [It.]

Cavalcaselle, B., and Bellis, E. De. 1971. [FURTHER EXPERIMENTS ON POPLAR WEEVIL CONTROL BY X-RAYS AND BY APHOLATE.] Pubbl. Cent. Sper. Agric. For. 11 (1): 47-53. [It.e., 40 ref.]

Ceianu, I., Radoi, D., and Coca, C. 1973. [CONTROL OF PARANTHRENE TABANIFORMIS [ON POPLAR].] Studii si Cercetari, Institutul de Cercetare, Proiectare si Documentare Silvica, I (Silvicultura) 29, 29-53 [Ro., 56 ref.]
The most economical treatment was spraying with Rogor (0.1-0.2 litre in 100-150 litres water/ha) two weeks after the beginning of the flight period. Other trials showed that injections of CCL_4 were 90-95% effective and relatively cheap, and these should remain the principal control measure.

Ceianu, I., Radoi, D., and Constantinescu, E. 1967. [PARANTHRENE TABANIFORMIS: STUDIES ON ITS BIOLOGY AND CONTROL.] Institutul de Cercetari Forestiere, Bucharest. pp. 96. [122 refs. [Rum.ru.g.ru.g.].]
Based on Rumanian studies and on European and American literature.

Chalfant, R. B. 1969. CONTROL OF THE POPLAR PETIOLE GALL APHID ON TURNIP ROOTS. J. Econ. Entomol. 62 (6): 1519.

Chandhry, G. U. 1969. INSECT PESTS AND DISEASES OF POPLARS IN WEST PAKISTAN; A SPECIAL REPORT FOR 1968. Pakistan Forest Institute, Peshawar, Pakistan Forest Institute, 41 p.

Chararas, C. 1968. [ENTOMOLOGICAL PROBLEMS OF POPLAR GROWING.] Bull. Serv. Cult. Etud. Peuplier et Saule, Paris (87-98). [F.]
A brief discussion of the main pests in many countries, their chief location on the host, factors affecting their degree of harmfulness, etc.

Chararas, C. 1969. [NUTRITIONAL PREFERENCES AND ENZYME ACTIVITY OF CRYPTORRHYNCHUS LAPATHI.] Bull. Serv. Cult. Etud. Peuplier et Saule (155-75). [F., 18 refs.]

Chararas, C. 1970. [ECOLOGICAL ASPECTS OF CERTAIN WOOD-BORING INSECT PESTS OF POPLARS.] Bull. Serv. Cult. Etud. Peuplier et Saule (1-16). [F., 22 refs.]

Chararas, C. 1971. [BIOLOGY, ECOLOGY AND BIONOMICS OF MELANOPHILA PICTA, A WOOD BORER SPECIFIC TO POPLARS.] Bull. Serv. Cult. Etud. Peuplier et Saule (41-54). [F., 27 ref.]
No particular species or clone of Poplar seems to be preferred. Trees in favourable growth conditions, and with limited fluctuations in osmotic pressure are best able to resist attack. Best control, therefore, is achieved by the creation and/or maintenance of such favourable conditions.

Chararas, C. 1972. [INSECT PESTS OF POPLAR – THEIR BIOLOGY, ECOLOGY, HARMFULNESS AND CONTROL.] Paris, France, Librarie de la Faculte des Sciences. 372 pp. [F., many ref., Price F100] From review in Revue Forestiere Francaise 25 (1), vii. F.
A comprehensive study based partly on the author's observations in Turkey and partly on wide knowledge of the work of other entomologists concerned with Poplars.

Chararas, C. 1973. [POPLAR INSECTS (BIOLOGY, ECOLOGY, INJURIES AND CONTROL).] Paris, France, Librarie de la Faculte des Sciences. 372 pp. [F., Price F.100] From Schweizerische Zeitschrift fur Forstwesen 124, 147-148. F.

Chararas, C., and Chardenon, J. 1965. [INFLUENCE OF ECOLOGICAL FACTORS AND OF THE VITALITY OF THE HOST ON THE ADAPTATION AND SPREAD OF CAPNODIS MILIARIS.] C. R. Acad. Sci., Paris 261 (12), (2390-2). 2 refs. [E.f.] O.R.S.

Chararas, C., Karagoz, O., and Sekendiz, O. 1965. [THE PRIMARY OR SECONDARY BEHAVIOUR OF MELANOPHILA PICTA (COL. BUPREST.) AND THE ATTRACTION EXERCISED BY THE HOST PLANT.] C. R. Acad. Sci., Paris 261 (22): 4841-4. 4 refs. [F.] O.R.S.
Its climatic requirements and biology are briefly described.

Chararas, C., and Laurant-Hube, H. 1970. [NUTRITION AND ENZYME ACTIVITY OF CERTAIN XYLOPHAGOUS PARASITES OF VARIOUS POPLARS.] Bull. Serv. Cult. Etud. Peuplier t Saule (17-31). [F., 33 refs.]
Data on enzymes of Melanophila picta, Cryptorrhynchus lapathi, Polyphylla Fullo, Sciapteron tabaniforme and Capnodis miliaris are tabulated and compared.

Chatterjee, P. N., Singh, P., and Prasad, G. 1969. INSECT PESTS OF FAST GROWING TREE SPECIES. II. EFFECT OF VARIOUS FUMIGANTS ON POPLAR STEM BORER, APRIONA CINEREA CHEVROLET (LAMIIDAE) IN NEW FOREST PLANTATIONS. ndian For. 95 (5): 369-71 + 4 figs.). [4 refs.]

Chatterjee, P. N., and Thapa, R. S. 1964. INSECT PESTS OF FAST GROWING TREE SPECIES. I. PRELIMINARY INVESTIGATION ON POPLAR STEM AND ROOT BORER, APRIONA CINEREA CHEVROLAT (COLEOPTERA: LAMIIDAE) IN NEW FOREST. ndian For. 90 (10), (681-7 + 2 plates). 10 refs.

Chaudhry, M. I., and Ahmad, M. I. 1973. BIOLOGICAL STUDIES ON LEAF STITCHER OF POPLARS, GYPSONOMA HAPALOSARCA MEYR IN PAKISTAN. Pakistan Journal of Forestry 23 (4): 363-371. [E., 3 ref.]
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Szontagh, P. 1966. [INSECT PESTS OF POPLAR STOOL-BEDS AND THEIR CONTROL.] Erdesz. Kutatas., Budapest 62 (1/3): 307-13. [6 refs. [Hu.ru.g.].]
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Wouters, L., and Vis, J. 1971. [EXPERIENCE WITH THE USE OF PREPARATIONS OF LOW TOXICITY TO CONTROL LARVAE OF STILPNOTIA [LEUCOMA] SALICIS IN POPLAR STANDS IN EAST FLEVOLAND.] Populier 8 (3): 50-2. [Nl., 1 ref.]
Describes aerial spraying trials in 1969 and 1970 with Dipterex and Tribactur, and also, in 1970 only, with Gardona (SD 8447) and Thuricide H.P.

Yoo, K. J. 1972. [STUDIES ON THE BIONOMICS OF XYLOTRECHUS RUSTICUS (COL., CERAMBYCIDAE).] Korean Journal of Plant Protection 11 (1): 11-14. [Ko., 2 ref. From Review of Applied Entomology, A 62, 1546.]
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459 OTHER ANIMALS

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Discusses Cenopalpus lineola on Pinus spp. in a number of Mediterranean countries and Iran. In Iran, the mite was also found on Cupressus sempervirens, Populus X canadensis, and species of Prunus and Malus. In some cases C. lineola colonies were found in the webs of Oligonychus ununguis. Another mite occasionally found in the colonies is identified with Brevipalpus kalandadzei and transferred to Cenopalpus.

Peterson, L. O. T., and Worden, H. A. 1964. CHEMICAL CONTROLS FOR RED SPIDER MITE [TETRANYCHUS TELARIUS L.]. Extr. from Summ. Rep. For. Nursery Sta. Sask. 1963. (15).
Systox (2·4 lb./gal.) and dimethoate (4 lb./gal.) consistently reduced populations by 81-99% for more than a month after application.

Tomasevic, B. 1964. [THE YELLOW POPLAR MITE EOTETRANYCHUS POPULI.] Zast. Bilja 15 (82): 687-93. 5 refs. [Serb.serb.e.e.] I.M.I.
Under natural conditions (temperature ca. 22° C.), total development took ca. 18 days. First eggs appeared in late April to early May. Phenkapton at 0·1% and Kelthane at 0·2% gave good control. 'Etiol' at 0·3 and diazinon at 0·2% were slightly less effective.

Wilson, N. S., and Oldfield, G. N. 1966. NEW SPECIES OF CRIOPHYID MITES FROM WESTERN NORTH AMERICA, WITH A DISCUSSION OF CRIOPHYID MITES ON POPULUS. Ann. Ent. Soc. Amer. 59 (3): 585-99. [14 refs. O.R.S.]
Describes and illustrates with photomicrographs 8 species recorded in the western U.S.A. and Mexico.

46 DAMAGE TO TREE GROWTH BY MAN

469 MISCELLANEOUS

Diaz-Colon, J. D., Bovey, R. W., Davis, F. S., and Baur, J. R. 1972. COMPARATIVE EFFECTS AND CONCENTRATION OF PICLORAM, 2, 4, 5-T AND DICAMBA IN TISSUE CULTURE. Physiol. Plant. 27 (1): 60-74. Ref.

48 INJURIES DUE TO UNKNOWN OR COMPLEX CAUSES

Breuel, K., and Bortitz, S. 1965. [THE ETIOLOGY OF 'BRAUN FLECKENGRIND', A BARK NECROSIS OF THE GENUS POPULUS.] Phytopath. Z. 52 (4): 305-18. 26 refs. [G.g.e.] O.R.S.
Discusses the nature of the disease, its primary symptoms, and the changes in structure and colour of the wood.

Breuel, K., and Bortitz, S. 1966. [THE ETIOLOGY OF 'BRAUN FLECKENGRIND', A BARK NECROSIS OF POPLAR.] Sozial Forstw., Berl. 16 (8): 246-8. [G.]
[Cf. F.A. 27 No. 4493.] Summarizes results of studies on the symptoms and nature of the disease and the susceptibility of Popla varieties. The primary pathogen is Dothichiza populea. Certain bark substances, and moisture and temperature, affect susceptibility.

Breuel, K., and Borttiz, S. 1966. [THE ETIOLOGY OF 'BRAUN-FLECKENGRIND', A BARK NECROSIS OF POPLAR. 2. STUDIES ON ITS CAUSE.] Phytopath. Z. 57 (1): 59-78. [37 refs. [G.g.e.] O.R.S.]
[Cf. F.A. 28 No. 1061.] Metabolites in bark in winter and spring, metabolic anomalies, winter temperatures, and water deficit in the bark were studied, but none was the primary cause of the disease. The concentration of populations of micro-organisms in damaged bark was related to the degree of damage to the tissues; a number of fungi and bacteria were found in the necrotic area, but only Dothichiza populea in the reaction area.

Leontovyc, R., and Gemersky, V. 1965. [BRAUNFLECKENGRIND ON POPLARS IN SLOVAKIA.] Ved. Prace Vysk. Ust. Lesn. Hosp., Banks. Stiav. 6: 195-228. [28 refs. [Slovak.slovak., ru.g.].]
A review which indicates that the pathogen is a bacterium as yet unknown (i.e. not Micrococcus populi). The development of the disease in Slovakia, and invasion of wounds by decay fungi, is surveyed, and the relative susceptibility of various hybrids, cultivars and varieties is determined.

Leontovyc, R., and Gemersky, V. 1968. [THE EFFECT OF 'BRAUNFLECKENGRIND' ON THE INCREMENT OF POPLARS.] Ved. Prace Vyskum. Ust. Lesn. Hosp., Zvolen No. 10: 231-45. [Slovak.ru.e.g., 6 refs.]

Peno, M. 1967. ['BRAUNFLECKENGRIND' IN POPLARS.] Topola, Beograd 11 (61/64): 149-55. [14 refs. [Serb.serb.f.].]
Only Dothichiza populea produced the symptoms of the disease in inoculation tests. A relationship was found between damage by thrips and the disease, 12-43% of thrips wounds examined leading to later fungus infection. It is suggested that the original areas of damage caused by the thrips and D. populea are colonized later by the other organisms.

Urosevic, B. 1965. CONTRIBUTION TO THE PROBLEM OF ETIOLOGY OF BROWN BARK SPOTTING ['BRAUNFLECKENGRIND'] ON POPLARS. Commun. Inst. For. Csl. 4: 155-73. 31 refs. [E.e.ru.]
Organisms isolated from infected areas included: (1) bacteria – Erwinia and Pseudomonas; (2) semi-parasitic fungi; and (3) epiphytic (saprophytic) fungi – Myxomycetes, Phycomycetes. Ascomycetes and Deuteromycetes. It is suggested that the primary cause of the disease may be the joint pathogenic effect produced by (1).

5 FOREST MENSURATION

52 MEASUREMENTS OF STEM DIMENSIONS AND VOLUME OF TREES, STANDS, FORESTS AND TIMBER

521 DIAMETER (GIRTH) AND SECTIONAL AREA

Georgopoulos, A., and Asteres, K. 1965. [THE ACCURACY OF D.B.H. MEASUREMENTS ON TREES. FIRST COMMUNICATION: POPLAR.] Repr. from Epeteris tes Geoponikes kai Dasologikes Scholes, Aristoteleion Panepistemion Thessalonikes, Thessalonike (343-63 + 4 photos). 21 refs. [Gk.g.g.]
In marilandica planted in 1951, the ratio of the longest diameter (d_1) to the one ⊥ to it (d_2) decreased from 1·1 in the most heavily thinned stand (mean d_1 46·6 cm.) to 1·059 in the unthinned stand (28·8 cm.). The arithmetic mean of d_1 and d_2 did not differ significantly from the diameter at 45° to either.

523 BARK (INCLUDING BARK INCREMENT)

Honer, T. G., and Alemdag, I. S. 1972. EQUATIONS FOR ESTIMATING INSIDE AND OUTSIDE BARK DIAMETERS AT BREAST HEIGHT OF ELEVEN TREE SPECIES FROM EASTERN AND CENTRAL CANADA. Information Report, Forest Management Institute, Canada, No. FMR-X-48, v + 11 pp.

523.3

Decei, I. 1964. [BARK % IN QUERCUS SESSILIFLORA COMPARED WITH OTHER SPECIES.] Rev. Padurilor 79 (2): 89-91. 10 refs. [Ro.]
Compares bark % and thickness of Q. sessiliflora and Q. robur for d.b.h. 2-70 cm., with some comparative data for several species, including aspen and black poplar.

Knezevic, I. 1969. [BARK PERCENT IN POPLAR AND WILLOW LOGS.] Topola, Beograd 13 (71/72): 17-20. [Serb.e., 2 refs.]

Markovic, J. 1970. [THE BARK VOLUME PERCENT AS MEASURED IN 'COMMERCIAL' CLEAN BARKING OF POPLAR AND WILLOW PULPWOOD.] Topola 14 (77/78): 8-18. [Serb.e.]
Investigations were made on round and cleft pulpwood of Populus nigra, P. X marilandica, P. X serotina, and Salix alba, 'commercially' clean-barked at stump in Jugoslavia.

524 DETERMINATION OF THE VOLUME OF TREES AND STANDS

524.3

Castellani, C. 1970. [VOLUME AND YIELD TABLES FOR THE ITALIAN FORESTS.] Ann. Ist. Sper. Assest. For. Alp. 1 (1): 431. [It.]
Presents in one volume a comprehensive edited collection of the available Italian volume tables and yield tables for many species of conifers and hardwoods. There are also some tables for coppice stands of some species.

Janeva, C. N. 1967 [THE AMOUNT OF STUMP AND ROOT WOOD IN POPLAR.] Gorsko Stopanstvo 23 (4): 12-5. [Bulg.]
From studies in a 22-year regenerata plantation of mean diam. 26 cm. and mean height 20·8 m., tabulates data on the actual volumes of stump and root wood in cu.m./ha. and as a % of stem vol., on plots cleared by tractor and by hand.

Korsun, F. 1967. [VOLUME AND YIELD TABLES FOR POPLAR.] Lesn. Cas., Praha 13 (11): 977-92. [24 refs. [Cz.cz.ru.g.].]
Presents new and more reliable tables based on measurements of a total of 1478 trees (mostly Populus [deltoides var.] monilifera) in different parts of Czechoslovakia, and on surveys made of 252 sample plots.

Moiseenko, F. P., and Zepnov, V. I. 1970. [VOLUME AND VALUE TABLES FOR SIMPLIFIED EVALUATION OF STANDING TREES.] Izdatel'stvo Lesnaya Promyshlennost', Moscow. pp. 520. [Ru., NLL]
Gives comprehensive tables of stem volume and value by stumpage zones and height categories for the ten principal forest trees (including Aspen) of European Russia.

524.315

Muller, R. 1974. GROSSCURTHS MASSEN- UND ERTRAG-STAFELN. Waldarbeit, Strassenhaus 25 (5): 105-120. [2 Abb., 1 graph. Darst., 6 Tab., 11 Lit. Ang.]

Ratzel, K. 1968. UNTERSUCHUNGEN UBER INHALT UND FORM DER PAPPELSORTEN NEUPOTZ, MARILANDICA UND ROBUSTA. Holzzucht, Reinbek 22 (3): 26-28. [3 Abb., 1 Tab., 7 Lit. Ang.]

525 VOLUME BY ASSORTMENTS. MERCHANTABLE VOLUME

Derioldi, A. 1970. [EVALUATION OF STANDS DESTINED FOR FELLING AND PLANNING OF ASSORTMENTS BY SIZE CLASSES ON THE BASIS OF STEM-NUMBER-DISTRIBUTION TYPES IN POPLAR STANDS IN HUNGARY.] Erdesz. Kutatas. 66: 69-118. [Ru., 10 ref.]
A detailed treatment of the application of the method to Populus spp.

Grabenstedt, H. 1968. MASSEN- UND GELDERTRAGE DURCH NUTZUNG HIEBSREIFER SCHWARZPAPPELN. Holzzucht, Reinbek 22 (1/2): S.12.

Moskalev, A. G. 1973. [ALLOCATION OF ASSORTMENT AND PRODUCT-GROUP TABLES FOR PINUS, PICEA, BETULA AND POPULUS STANDS IN THE EUROPEAN PART OF THE USSR.] In Voprosy Lesoustroistva Taksatsii i Ekonomiki Lesnogo Khoziaistva, p. 188-198. [Ru.]

526 LOG MEASUREMENT. "SCALING"

Anonymous. 1965. WOOD MEASUREMENT CONCEPTS IN ONTARIO. Timber Section, Department of Lands and Forests, Ontario. pp. 12.
Discusses: volume scaling for tree lengths from local butt volume tables; pre-cut cruising; and weight scaling. In a recent study, % species composition (of Spruce, Balsam, Fir, Jack Pine and Aspen) had little effect on weight per cord (ca. 4000 lb.).

527 SOLID VOLUME OF STACKED PRODUCTS (INCLUDING CONVERTING FACTORS)

Derfoldi, A. 1966. [SOLID VOLUME OF PULPWOOD.] Kutatas., Budapest 62 (1/3): 227-40. 2 refs. [Hu.ru.g.]
Conversion factors from stacked to solid measure are presented for conifers (Scots Pine and Pinus nigra and Spruce). Black Poplar hybrids, native Poplars, Willows and Quereus cerris, varying from 0·638 (native Poplars) to 0·682 (conifers).

Lupusanschi, S. 1967. ['SPECIFIC TECHNOLOGICAL CONSUMPTION' IN THE PREPARATION OF PULPWOOD FROM STACKED WOOD OF DIFFERENT LIGHT HARDWOOD SPECIES.] Rev. Padurilor 82 (2): 74-80 + smries.). [15 refs. [Ro.ru.g.f.e.].]
Indexes have been derived for both hand- and machine-barked pulpwood of Willow, Poplar, Lime, Alder, and Birch.

53 SPECIAL MEASUREMENTS OF TREES AND STANDS (CROWN DIMENSIONS, STAND DENSITY, ETC.)

532 QUANTITY AND AREA OF FOLIAGE

Vysotina, G. P., and Kuz'michev, V. V. 1974. [CROWN PHYTOMASS OF MATURE BIRCH-ASPEN STANDS IN NORTHERN KAZAKHSTAN.] Lesovedenie 2: 88-92. [Ru.e.]

533 CROWN DENSITY OF STANDS

Fakirov, V. 1969. [POSSIBILITIES OF DETERMINING STAND CANOPY DENSITY.] Gorskostop. Nauka, Sofija 6 (4): 31-44. [Bulg.ru.g.] 25 refs.

54 ASSESSMENT OF SITE QUALITY

Warner, J. H., and Harper, K. T. 1972. UNDERSTORY CHARACTERISTICS RELATED TO SITE QUALITY FOR ASPEN IN UTAH. Brigham Young Univ. Sci. Bull. Biol. Serv. 16 (2): 20.

541 BASED ON HEIGHT, DIAMETER, VOLUME, ETC.

Davidov, M. V. 1964. [DETERMINING THE SITE CLASS OF STANDS OF FAST-GROWING SPECIES.] Lesn. Z., Arhangel'sk 7 (4): 18-20. 3 refs. [Ru.]
For fast-growing species such as Robinia, Willows, and Poplars, tables of heights for several site classes and ages are presented.

Schmitz-Landers, B. 1968. DURCHMESSER-BONITIERRUNG BOL SCHWARZPAPPELN. Forst-Holzwirt, Hann. 23 (23): S.481.

547 RELATION OF FOREST SITE QUALITY TO THE PRODUCTION OF WOOD

Hased, J. 1973. [EFFECTS OF LOCAL VARIATIONS IN SITE ON VITALITY, RATE OF GROWTH AND PRONENESS TO DAMAGE OF POPLAR PLANTATIONS.] Acta Univ. Agric., Fac. Silvic. 42 (2): 139-160. [G.e.]

55 AGE DETERMINATION

Romashov, N. V. 1969. [ESTABLISHING THE AGES OF CUTTINGS IN POPULUS AND SALIX ALBA FORESTS IN THE UKRAINE.] Lesovod Agrolesomelior. [Ru.]

56 INCREMENT: DEVELOPMENT AND STRUCTURE OF STANDS

Avanzo, E. 1966. [DENDROMETRIC INVESTIGATIONS ON POPLARS PLANTED IN ROWS IN THE FUCINO [PLAIN].] Pubbl. Cent. Sper. Agric. For., Roma 8: 5-17. [10 refs. [It.it.e.e.].]
Measurements in 1962 of euramericana, mainly cv. 'I-214', planted in (a) single and (b) double rows in 1952, showed 23-43% losses. Mean height in single rows planted 4 m. apart was 20·3 m. and mean volume 0·915 cu.m. per tree. Rotation age is estimated at 21 years, with mean volume 2·7 cu.m. per tree. At 10 years, m.a.i. was 13·3 and 20·28 cu.m./km. in (a) and (b) respectively.

Cifra, J. 1971. [PRESENT GROWTH OF POPLARS IN SAMPLE LIGNICULTURES IN SLOVAKIA.] Lesn. Cas. 17 (3): 259-271. [Slo.e.]

Giurgiu, V. 1967. [OPTIMUM EXPLOITABLE AGE OF HYBRID BLACK POPLAR STANDS.] Rev. Padurilor 82 (9): 457-63. [11 refs. [Ro.e.f.g.ru.].]
Populus X euramericana in the Danube Delta grows rapidly at 15-25 years of age on good sites, and should not be felled earlier than 15 years.

Giurgiu, V. 1970. [THE GROWTH OF HYBRID BLACK POPLAR STANDS.] Stud. Cerc. Inst. Cerc. Silvice 27 (2): 501-13. [Ro.f.de., 10 ref.]
Another version of work already noticed. Includes height and d.b.h. curves for five site classes. The results agree with the 1960 yield tables of S. Armausescu, et al. Effects of flooding are discussed.

Grosscurth, W. 1968. [VOLUME AND FINANCIAL YIELD OF MATURE POPLAR STANDS.] Holzzucht, Reinbek 22 (1/2): 6-12. [12 refs. [G.g.e.].]
Presents data for 8 stands of various Black Poplar hybrids aged 29 to 37 years from N. and S. West Germany. Under optimum conditions of site, establishment, tending, fertilizing and pruning, annual net returns of DM. 1200/ha. are possible and of up to DM. 44,000 for the final cut. Maximum m.a.i. at age 33 was 21·8 cu.m.

Iliev, A., Bogdanov, B., and Iliev, S. 1970. [YIELD OF SOME FORMS OF BLACK POPLARS.] Gorsko Stopanstvo 26 (4): 19-23. [Bulg.]
Gives details of dimensions and yield of 10 Black Poplars in Bulgaria at 5, 6, 7 and 8 years. 'I-214' had by far the highest yield, followed by P. X 'canadensis hB6', P. 'Vernirubens', and P. trichocarpa.

Jenko, V. 1971. [PLANTATION PRODUCTION OF POPLAR WOOD IN YUGOSLAVIA.] Les (1 jubi jana) 23 (5/6): 89-91. [Slovak.]

Nikolandic, S., Munkacevic, V., and Jovic, D. 1971. [INCREMENT OF SOME HYBRID BLACK POPLARS AND SALIX ALBA IN VARIOUS FOREST TYPES ON ALLUVIAL SOILS OF BAR ANJA, [YUGOSLAVIA].] Topola 15 (83/85): 41-7. [Sh.e., 18 ref.]
For the best hybrid Black Poplars (mainly Populus 'I-214') the best forest type is the Ulmeto-Fraxinetum typicum on moist and fairly moist alluvial para-rendzina; for S. alba the best type is the Rubeto-Salicetum albae on y-gley and very moist alluvial para rendzina.

561 INCREMENT IN HEIGHT, DIAMETER, BASAL AREA, FORM AND QUALITY

Anonymous. 1969. [POPLAR GROWING IN HUNGARY.] Erdesz Kutatas. 65 (2/3): 70-81, 111-38, 287-96. [Hu., 15 refs.]
Papers in this issue include: Clone trials in Populeta. Site requirements in raising high-grade Poplar propagating material. Structure and yield of P. 'Robusta' stands of the Nyireseg region, and Mechanizing the raising of Poplar propagating material in centralized nurseries.

Badan, R. 1965. [THE DENDROMETER AT THE 'EXPO' [SWISS NATIONAL EXHIBITION].] Schweiz. Z. Forstw. 116 (4/5): 429-32. [F.]
Describes an improved electrical self-registering dendrometer in which strain gauges are mounted on a special highly elastic rubberized material of very high electrical resistance; results of 3 months' study of a Poplar stem are discussed. The S curve of increment within 24 hr. reflected the course of transpiration under the influence of temperature and r.h. Daily maxima occurred later as the growing season progressed (5-6 a.m. in June, 9-10 a.m. in early Aug.). Greatest growth occurred between 13 June and 5 Aug. Thunderstorms caused rapid diam. increases (up to 3 mm. in 15 min.) 1 to 2 hr. later. Gales compensated the effect of high transpiration and slowed down increment.

Kern, K. G. 1970. [ENVIRONMENTAL FACTORS AFFECTING THE INCREMENT OF POPLARS IN THE RHINE FLOOD PLAIN.] Allg. Forst- u. Jagdig. 141 (4): 83-6. [G.e.f., 2 refs.]
The effect of factors such as total radiation, soil, and air temperatures, precipitation, ground-water and flood levels, was studied over two or three growing seasons on 4 Populus 'Marilandica' and 2 P. 'Robusta' aged 35 years in the Rhine flood-plain near Speyer. Water supply was never less than ample. The highest monthly % of total diameter increment coincided with the month of the highest radiation (June or July). Flooding (occurring once or twice in the growing season) reduced increment.

Maksaeva, L. D. 1966. [DYNAMICS OF THE INCREMENT OF PLANTATION POPLARS DURING THE GROWING SEASON.] Sborn. Rabot Lesn. Hoz. Vsesojuz, Nauc.-Issled. Inst. Lesovod. No. 51: 49-59. [Ru.ru.]
Most Poplars produced 90% of their height increment in June and July. In Populus trichocarpa, P. 'Hybrid 5 Berezin', and P. nigra var. italica X P. wislizenii, height increment was directly related to temperature and rainfall. In P. suaveolens, P. 'Hybrid 5 Berezin', P. trichocarpa, and P. 'Pioneer', the maximum mean daily increment coincided with the highest temperatures, whereas in P. nigra var. italica, P. 'Micurinee', p. 'Hybrid 773', P. X 'cannadensis' and P. 'nigra var. italica X P. wislizenii the maximum increment was observed at the end of June. Total growing season ranged from 65 days in P. suaveolens to 118 days in P. nigra var. italica X P. wislizenii, but no correlation was found between the annual height increment and the total duration of growth.

Papadopol, C. S. 1968. [ECOLOGICAL ASPECTS OF THE RADIAL INCREMENT OF POPLARS GROWN ON THE STEPPE.] Rev. Padurilor 83 (3): 112-6 + smries.). [7 refs. [Ro.f.e.g.ru.].]
Mainly phenological data on growth of nigra var. italica, P. nigra var. thevestina, P. X robusta, P. X regenerata, P. simonii, P. X generosa, and Salix alba. The influence of distribution of rainfall and length and date of onset of drought periods is stressed.

Volkov, S. V., and Vasil'ev, P. M. 1970. [ON THE RATE OF GROWTH AND COMMERCIAL ORGANIZATION OF ASPEN FORESTS OF THE SPOKOOINENSKII MECHANIZED FORESTRY ENTERPRISE.] Les. Zh. 1: 157-159. [Ru.]

Voznesenskaja, E. I. 1970. [STEM DIAMETER GROWTH RATE OF WOODY PLANTS IN TADZHIKISTAN.] Uc. Zap. Dusanbinsk.

Gos. Ped. Inst. 67: 107-12. [Ru.]
Irrigation caused a great increase in diameter increment in Tadzhikistan. Species having a mean annual diameter increment >20 mm. with irrigation in Tadzhikistan were: Robinia pseudoacacia, Ailanthus sp., Ulmus laevis, Acer negundo, Juglans regia, Poplars, Willows, etc. Without irrigation, the mean diameter increment, even of the fastest growers – e.g. Ailanthus sp., did not exceed 6-8 mm.

562 VOLUME INCREMENT

Chardenon, J. 1971. [THE YIELD OF A POPLAR STAND ACCORDING TO GIRTH, ANNUAL GIRTH INCREMENT, LOG LENGTH AND NUMBER OF TREES PER HA.] Bull. Serv. Cult. Etud. Peuplier et Saule (36-40). [F.]
Presents a series of graphs showing the volume yield in logs 8 or 10 m. long according to the g.b.h. increment (measured annually), for Poplar stands spaced at 158 or 200 trees/ha.

Goni, J. C., and Reuter, H. R. 1971. [VOLUME MEASUREMENTS IN SHELTERBELTS IN SANTIAGO DEL ESTERO [ARGENTINA].] In Actas del 'Primer Congreso Forestal Argentino,' 'Sesion B-III. Servico Nacional Forestal, Buenos Aires. pp. 542-6. [Es.]
Growth data are given for shelterbelts of Casuarina cunninghamiana, Populus spp. and Cupressus sempervirens in the irrigation area of Rio Dulce. C. sempervirens makes the slowest growth, but surpasses the other species in wood quality and effectiveness as a windbreak.

Dawson, D. H., and Crist, J. B. 1972. DRY WEIGHT YIELDS AND WOOD ANATOMY OF TWO POPULUS CLONES AFTER TWO SEASONS OF INTENSIVE CULTURES. [Abstract.] Sixth Forest Biology Conference TAPPI, May 1-3, 1972. Institute of Paper Chemistry, Appleton, Wis.

De Vries, P. G. 1966. [ESTIMATION OF MERCHANTABLE STEM VOLUME OF STANDING POPLARS.] Populier 3 (1): 11-13. [Du.]
A simple formula to approximate the volume contained in the merchantable stem is derived.

Prevosto, M. 1969. [GROWTH AND YIELDS OBTAINED OF VARIOUS POPLAR TYPES GENERALLY CULTIVATED IN THE LOWLAND OF LOMBARDY-PIEDMONT.] Cellulosa e Carta 20 (3): 51-54. [It.]

Prevosto, M. 1971. [GROWTH AND YIELD OF POPLAR TYPE MOST COMMONLY CULTIVATED IN THE LOMBARDY-PIEDMONT PLAIN.] Colt. G. Vinicolo Ital. 117 (1/2): 25-26. [It.]

Szodfridt, I. 1973. [YIELD AND SITE INVESTIGATIONS IN POPLAR STANDS IN HUNGARY.] Erdeszeti Kutatasok, Budapest, 68 (2): 35-40.

564 FORECASTING INCREMENT

Bella, E. 1970. SIMULATION OF GROWTH, YIELD AND MANAGEMENT OF ASPEN. Vancouver, University of British Columbia 190, illus.

566 YIELD TABLES AND THEIR CONSTRUCTION

Armasescu, S. 1971. [THE YIELD CHARACTERISTICS OF FOREST SPECIES IN RUMANIA.] Rev. Padurilor 86 (1): 22-5. [Ro.]
The most productive species of softwoods, heavy hardwoods, and light hardwoods are respectively Picea abies, Robinia pseudoacacia, and Populus X canadensis or Salix alba.

Bradley, R. T., Christie, J. M., and Johnston, D. R. 1966. FOREST MANAGEMENT TABLES. Bookl. For. Comm., Lond. No. 16, pp. 219.
Presents (1) general yield-class curves, (2) production-class curves, (3) thinning-control tables, (4) production-forecast tables, and (5) normal yield tables for several species, including Populus spp. There are also auxiliary tables (e.g. average b.a. stocking, height at age of maximum m.a.i. etc.), and Prefatory chapters on the use of management tables.

Cincaladze, T. G., and Gedenidze, A. A. 1964. [THE YIELD OF POPULUS X 'CANADENSIS', P. NIGRA VAR, ITALICA, AND P. BALSAMIFERA IN THE COLCHIS LOWLAND.] Lesn. Z., Arhangel'sk 7 (6): 167. [Ru.]
Presents a yield table to 14-16 years for this area of the Caucasus. P. balsamifera (at 928 stems/ha.) is doing much better than the other two (both at ca. 2000 stems/ha.).

Kozlovskij, V. B., and Pavlov, V. M. 1967. HOD ROSTA OSNOVNYH LESOOBRAZUJUSCIJ POROD SSSR. [YIELD TABLES FOR THE MAIN FOREST-FORMING SPECIES IN THE U.S.S.R.] Izdatel'stvo 'lesnaja Promyslennost', Moscow. pp. 327. [[Ru.] N.L.L.]
A compendium of 113 Soviet yield tables (6 for Populus tremula and 7 for fast growing species including P. spp.) for natural stands and plantations in various parts of the U.S.S.R. There are also 11 standard basal-area and stand-volume tables, and 5 tables for determining site classes.

Kr'stanov, K., Belyakov, P., and Popski, Ts. 1971. [VERIFICATION OF VOLUME IN PROVISIONAL POPLAR YIELD TABLES.] Gorsko Stopanstvo 27 (9): 34-9. [Bulg.]
Describes recent studies to check the accuracy of the tables used hitherto in Bulgaria, which are based on initial spacings of up to 4 X 4 m.

Schmitz-Lenders, B., and Lange, O. 1965. [INCREMENT AND YIELD OF THE 'HARFF' POPLAR (ADDITIONAL MATERIAL). II. FURTHER DEVELOPMENT OF THE YIELD TABLES OF 1948 AND 1951 FOR THE 'HARFF' POPLAR.] Forstarchiv 36 (5): 98-100. 3 refs. [G.]
Presents tables for ages 5 to 30, 35, and 40 years for 3 site classes (spacings 7 X 7, 7·5 X 7·5, and 8 X 8 m.) for Populus X regenerata 'Harff' [P. 'Regenerata Deutschland'], and curves for d.b.h. and height increment up to age 30.

568 OTHER MENSURATIONAL STUDIES OF STAND CONSTITUTION AND CHANGES THEREIN. DISTRIBUTION OF GROWTH BY TREE CLASSES, ETC.

Delvaux, J. 1966. [THE DEVELOPMENT OF STANDS. II. THE FREQUENCY DISTRIBUTION OF DIAMETERS AND HEIGHTS. III. THE COMPETITION FACTOR. IV. COMPETITION AT THE TREE-CLASS LEVEL.] Trav. Sta. Rech. Groenendas (Ser. B.) No. 32, pp. 46. [F.f.du.e.]

Fakirov, V. 1964. [NUMERICAL CHARACTERISTICS OF CERTAIN MENSURATIONAL INDICES OF THE TREES (BY GROWTH CLASSES) IN POPLAR STANDS.] Gorskostop. Nauka, Sofija 1 (6): 31-43. [[11 refs. [Bulg.ru.g.]
Covers form quotient, increment, leaf weight, branch volume and bark % for P. X regenerata.

Fakirov, V. 1964. [DISTRIBUTION OF TREE GROWTH CLASSES IN POPLAR STANDS.] Gorsko Stopanstvo 20 (5): 16-8. [Bulg.]
A tabular analysis of the distribution of tree classes in unthinned or lightly thinned Populus X regenerata stands aged 10, 13, and 20 years near the Danube in Bulgaria, using Nesterov's and Voropanov's classification. Recommendations are made on thinning intensity.

6 FOREST MANAGEMENT

61 FOREST MANAGEMENT: GENERAL, THEORY AND PRINCIPLES

Grosscurth, W. 1969. PREREQUISITES FOR AN ECONOMICAL POPLAR CULTURE. Mitt. Deut. Landwirt-ges 84 (14): 468-471. [G.]

Horavth, I., and Jaro, Z. 1974. POPULUS FOREST MANAGEMENT IN HUNGARY. Erdo. 12 (8): 375-378. [Hu.]

62 METHODS OF MANAGEMENT

Asthalter, K. 1974. DIE KOMBINIERTE METHODE DER FORSTLICHEN STANDORTSKARTIERUNG IN HESSEN ALS OKOLOGISCHE BASIS FUR REGIONALE UND UBERREGIONALE WUCHSVERGLEICHE UND PLANUNGEN. Entgegnung zu R. Muller "Kritik und Entfalschung einer Dissertation". Forstpflanzen-Forstamen, Strassenhaus, Neuwied 14 (3): 68-69. [15 Lit.Ang.]

64 FORESTRY AS A BUSINESS: GENERAL

Anonymous. 1968. GROWING POPLARS IS A DEVELOPING INDUSTRY. Power Farming Aust. N. Z. 77 (5): 14-16.

Becking, J. H. 1965. [THE CONTRAST IN ECONOMIC DEVELOPMENT OF THE DIFFERENT BRANCHES OF WOOD PRODUCTION.] Ned. Bosb. Tijdschr. 37 (10): 335-43. 9 refs. [Du.]
Discusses the unfavourable economic position of forestry in the Netherlands as compared with the wood industry, quoting actual figures for output and prices for growing Poplar and Norway Spruce.

Maisenbacher, H. 1970. [INDUSTRIAL UTILIZATION AND ECONOMIC PRODUCTION OF POPLAR WOOD.] Forst-archiv 41 (8): 150-4. [G.e.]
Discusses existing and potential demands for pulpwood and particle-board wood, pallets, small articles, matches and plywood, and the economics of Poplar-growing. Growing Poplars on 10- to 20-year rotations for cordwood is not considered economic. The production of veneer logs is considered the most promising object of management. It requires careful tending and pruning, and evidence for future purchasers of the pruning done.

643 CLASSIFICATION OF FOREST ENTERPRISES, THEIR BASIC ECONOMIC UNITS AND TYPES OF ECONOMIC MANAGEMENT

Salsotto, A. 1970. [ECONOMIC ADVANTAGE OF POPLAR CULTURE.] Cuneo Cam Com Indus Agr Not Camerale 25 (23): 1428-1432. [It.]

65 SPECIAL BUSINESS PROBLEMS OF TIMBER-GROWING

Anonymous. 1969. [FINANCIAL RESULTS OF POPLAR STANDS.] Populier, Wageningen 6 (1): 19. [Du.]
The entire number is devoted to a report by the working group on business economics of the Netherlands National Poplar Commission, based on Data for stands planted with 1-year plants at 200 trees/ha.

Anonymous. 1971. [DIRECTIONS FOR THE VALUATION OF FORESTS AND OF DAMAGE TO FORESTS.] Beih. Z., Schweiz. Forstw. No. 50, pp. 127. [De. or F., 9 ref.]

Anonymous. 1971. [FINANCIAL CONSEQUENCES OF USING VARIOUS [BROAD-LEAVED] SPECIES WHEN PLANTING NEW FORESTS.] Ned. Bosh. Tijdschr. 43 (6): 122-37. [Nl.e., 4 ref.]
Presents calculations, made on behalf of a working group on 'Forests in Urban Areas', of the financial results of the afforestation of grassland on clay soil in Holland.

Anonymous. 1971. FINANCIAL RESULTS OF POPLAR LINE PLANTATIONS. Ned. Bosh. Tijdschr. 43 (9): 201-6. [E.]
Summarizes the results of a study by the Poplar Economics working group of the National Poplar Commission of the Netherlands on the financial results of Poplar line plantings along the borders of agricultural land, especially grassland. Calculations are based on line plantations of 20 trees spaced 5 m apart, on sand or clay, established with 1- or 2-year planting stock, for rotations of 20, 25, and 30 years.

Anonymous. 1971. [FINANCIAL RESULTS OF POPLAR ROW PLANTINGS ALONG FIELD BORDERS.] Populier 8 (1): 3-21. [Du.]
Costs, growth, and profitability are discussed for plantings of Poplars (P. 'gelrica', 'Marilandica', and 'Robusta') in rows along the boundaries of pastured meadows assuming rows 100 m. long containing 20 trees each. In general, the use of 1-year plants would be more economical, and the return on capital invested would be greater for rotations of 20 years for 'Gelrica' on the best sites, and 20-30 years for the rest.

Becking, J. H. 1970. [THE FINANCIAL RESULTS OF POPLAR-GROWING IN THE NETHERLANDS.] Populier 7 (3): 37-46. [Du., 11 refs.]

Becking, J. H. 1971. THE FINANCIAL RESULTS OF POPLAR CULTIVATION IN THE NETHERLANDS. Transl. Dep. Fish. For. Can. No. OOFF 215. pp. 30. [11 ref. Transl. from Populier 1970 7 (3): 37-46.]

Delcampe, H. 1966. [THE FACTORS DETERMINING THE PROFITABILITY OF POPLAR PLANTATIONS.] Foret privee, Paris (49): 51-55. [F.]
The factors discussed are (1) the area planted. (2) method of financing, (3) location, (4) the marshiness of the site, (5) choice of planting stock, and (6) climatic effects and diseases.

Delcampe, H. 1966. [PROFITABILITY OF POPLAR PLANTATIONS ON MARSHY SOILS.] Foret privee, Paris 50: 29-37. [F.]
Describes the various means of financing Poplar planting available to private investors in France (subsidies, loans, tax reductions, etc.)

Delcampe, H. 1966. [THE PROFITABILITY OF POPLAR PLANTATIONS ON MARSHY SOILS.] Foret privee, Paris (51; 52), (37-46; 35-41). [F.]
Analyses the financing of plantations (a) by direct subsidies, (b) by loans from the Fonds Forestier National, and (c) by leasing the land to public or semi-public bodies (e.g. Syndicats Agricoles).

Dutrow, G. F., McKnight, J. S., and Guttenberg, S. 1970. INVESTMENT GUIDE FOR COTTONWOOD PLANTERS. U.S. For. Serv. Res. Pap. SO-59, pp. 15. [2 refs.]
Gives data on costs and returns for pulpwood and sawtimber rotations on high-, medium- and low-quality sites, and assumed future stumpage prices for the Mississippi Delta region. Even at current prices, high rates of return can be achieved on suitable sites.

Hubener, E., and Flory, E. 1969. [PRUNING OF POPLARS.] Sozial. Forstw., Berl. 19 (10): 305-7, 315. [4 refs. [G.g.].]
Pruning can be a profitable investment, but only for veneer assortments (d.b.h. not less than 40 cm.).

Iacovlev, A. 1967. [VALUATION CRITERIA FOR ASCERTAINING THE ECONOMIC IMPORTANCE OF FOREST SPECIES.] Rev. Padurilor 82 (1): 1-6 + smries. [12 refs. [Rum.ru.g.f.e.].]
Return in foreign exchange is the fairest criterion for estimating the relative economic value of different species, and on this basis it is considered that hybrid Black Poplars are the most profitable, where it is possible to grow them.

Kulcsar, V. 1964. [SOME QUESTIONS OF THE ECONOMIC SOUNDNESS OF PRODUCTION PROCESSES IN FORESTRY.] Arch. Forstw. 13 (8): 817-31. [G.g.ru.e.]
Contrasts the aims of capitalist and socialist enterprises, viz. profit vs. production for the community, and includes a consideration from the latter point of view of the economics of afforestation, using data from Poplar and Robinia stands.

Kulcsar, V. 1965. [THE EXPLOITATION VALUE OF POPLAR STANDS.] Erdo 14 (12): 540-5. [Hu.ru.g.]

Presents, on the basis of 125 stands of Black Poplar hybrids and 64 stands of Populus tremula in Hungary, diagrams and graphs showing assortments by diameter classes and values per ha. by age and site class.

Proni, G., and Prevosto, M. 1974. [ECONOMIC VICISSITUDES OF SPECIALIZED POPLAR GROWING IN THE PO VALLEY IN THE LAST TWENTY YEARS.] Cellulosa e Carta 25 (2): 3-12 [It.f.e.de., 2 ref.]
Discusses reasons for the decline in popularity of Poplar growing in northern Italy in recent years, especially the failure of prices for Poplar wood to keep pace with rising costs of production, the more favourable marketing conditions for competitive farm crops, and uncertainties regarding timber-production policy within the European Economic Community.

Thomas, B. U. 1964. GROWING OF HARDWOODS FOR PULPWOOD. Timb. Grower, Lond. No. 13, (26-31).
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651 CALCULATION OF COSTS AND PROFITABILITY

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Jaeger. 1972. ERTRAG UND VERWERTUNG VON PAPPELHOLZ. Holz-Zentralbl., Stuttg. 98 (115): S.1635.

67 ASSESSMENT OF FINANCIAL RESULTS; BOOKKEEPING AND ACCOUNTANCY; BUSINESS STATISTICS; SHORT-TERM PLANNING AND FINANCING

Mooy, J. J. 1968. [CALCULATION OF THE PROFITABILITY OF POPLAR CULTIVATION.] Populier 5 (3): 38-39. [Du.]

7 MARKETING OF FOREST PRODUCTS

ECONOMICS OF FOREST TRANSPORT AND THE WOOD INDUSTRIES

71 MARKETING OF FOREST PRODUCTS: GENERAL

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Becher, R., Lange, O., et al. 1973. [THE DEVELOPMENT OF THE MARKET FOR POPLAR WOOD IN WESTERN EUROPE.] Holzzucht 27 (2/3): 13-24. [De.]
A report on the regional Poplar Conference, Wageningen, 1973, plus conference papers by the second and third authors on, respectively, the development of production and prices of Poplar wood in Europe, and its utilization in the pulp and paper industry.

Coorens, P. J. H. 1967. [THE DEVELOPMENT OF THE DEMAND FOR POPLAR ROUNDWOOD.] Populier 4 (3): 38-40. [Du.]

International Poplar Commission. 1973. TRENDS AND PROSPECTS OF THE POPLAR WOOD MARKET IN THE WESTERN EUROPEAN REGION AND ITS CONSEQUENCES ON POPLAR GROWING AND RESEARCH. Report of the Regional Poplar Congress, Wageningen, The Netherlands, 7-10 May 1973. National Poplar Commission of the Netherlands. 31 pp. + 13 appendices [E.F.De.e.f., 8 ref.]
Presents a general report, conclusions and recommendations from this conference held at the International Agriculture Centre. Report includes 10 papers, primarily on processing and economics.

Meiden, H. A. van der. 1973. [IMPACT OF THE TIMBER MARKET DEVELOPMENT ON THE GROWING OF POPLAR AND ON POPLAR RESEARCH.] Report of the Regional Poplar Congress, Wageningen, the Netherlands, 7-10 May. [E.f.]

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Lange, O. 1969. DER PAPPELHOLZMARKT IM FORSTWIRTSCHAFTSJAHR 1969. Holz-Zentralbl., Stuttg. 95: 155/156/157.S.2406 u. 2408. [2 Abb., 1 Tab.]

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72 THE QUANTITATIVE ASPECTS OF MARKETING; DEMAND AND SUPPLY

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Adema, K. 1964. [FACTORS EFFECTING THE PRICE OF POPLAR WOOD.] Populier 1 (1): 2-3. [Du.]

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Lange, O. 1973. PRODUCTION AND PRICES OF POPLAR WOOD. Report of the Regional Poplar Congress, Wageningen, the Netherlands. [E.]

Sakman, E. 1971. STUDY OF MARKET VALUE FOR POPLAR PRODUCTS IN ARBIL [IRAQ.] Report, UNDP/FAO Forestry Research, Demonstration and Training Project, Arbil, Iraq No. RD 15, pp. 23, [E.]
A 'market-value table' is presented showing the value (in fils) of logs 1, 1-1/2, 2 . . . 8 m long, of mid-diameters 5, 6, 7 . . . 33 cm. The table can be used for valuation of Poplar plantations.

Sipkens, J. 1974. [STRONGLY INCREASED PRICES FOR POPLAR PULPWOOD.] Populier 11 (4): 84. [Du.]

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Sipkens, J. 1972. [THE SALE OF POPLAR PULPWOOD.] Populier 9 (4): 67-70. [Du.]

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Daignault, L. G. 1969. ECONOMICS OF MANUFACTURE OF WOOD COMPONENTS. Forest Prod. J. 19 (1): 13-15.
Some of the important factors to be considered in setting up a dimension stock plant are acceptable species, grade economics, and investment costs. Species that find best acceptance are yellow birch, hard maple, white birch, and aspen.

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Food and Agriculture Organization. 1968. [MAN-MADE FORESTS: UTILIZATION.] In FAO world symposium on man-made forests and their industrial importance. FAO, Rome. [Many refs. [E.F.Span.].]

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A review of the present and potential uses of the four main Canadian species of Poplar (P. tremuloides, P. grandidentata, P. balsamifera and P. trichocarpa).

81 WOOD AND BARK: STRUCTURE AND PROPERTIES

Anonymous. 1971. [RESEARCH ON POPLAR WOOD, MADE IN THE EARLY PERIOD OF THE NATIONAL POPLAR COMMISSION.] Report H 71-78 Houtinstituut TNO (Forest Products Research Institute TNO), Delft. [Du.]

Anonymous. 1972. [IS THERE A POSSIBILITY TO ESTIMATE IN AN EARLY STAGE OF THE TREE THE QUALITY OF POPLAR WOOD?] Report H 72-34 Houtinstituut TNO (Forest Products Research Institute TNO), Delft. [Du.]

810 GENERAL INFORMATION ON WOODS

Anonymous. [n.d.] [REFERENCE NOTES ON THE PRINCIPAL SPECIES OF THE TEMPERATE COUNTRIES – POPULUS SPP.] Centre Technique du Bois, Paris. pp. 15. [[F.] P.R.]

Anonymous. 1970. [THE POPLAR.] Lotta Antiparassitaria 22 (11): 12-13. [It.]

Gotze, H. 1964. [STUDIES ON SOME PROPERTIES OF POPLAR WOOD. I. FIRE RESISTANCE, CUTTING RESISTANCE, ABRASION RESISTANCE AND HARDNESS OF POPLAR. II. SHEAR, CLEAVAGE AND IMPACT BENDING STRENGTHS AND DURABILITY OF POPLAR.] Holzindustrie, Berlin 17 (7; 8): 187-90; 224-7. 25 refs. [G.] P.O.

Gutierrez, O. A., et al. 1967. [TECHNOLOGICAL STUDY OF THE WOOD OF POPLARS CULTIVATED IN SPAIN.] An. Inst. For. Invest. Exp., Madrid (231-362). [Span.span.f.e.g.]
Gives in detail the results of tests on wood properties from five clones of Populus X 'canadensis', viz. 'Campeador', 'I-214', 'I-488', 'Negrito de Granada', and 'Pinseque'.

Kesemeyer, A. W. 1969. [USES OF POPLAR WOOD IN INDUSTRY AND SMALL-SCALE MANUFACTURE.] Holzzucht, Reinbek 23 (3/4): 29-34. [G.]
Discusses uses for Poplar wood, mainly in N.W. Germany.

Kraayenoord, C. W. S. van. 1968. POPLAR AS A TIMBER TREE. Bull. National Plant Materials Centre, Ministry of Works and Development, N.Z., 10 pp.

McKnight, J. S. 1971. COTTONWOOD (POPULUS SPECIES). Amer. Woods U.S. For. Serv. No. FS-231, pp. 8. [11 ref.]
The only commercial species of 'Cottonwood' in the USA are P. deltoides and P. trichocarpa.

Pahomov, J. D. 1965. [PHYSICAL AND MECHANICAL PROPERTIES OF THE WOOD OF [SOVIET] FAR EASTERN SPECIES.] Izdatel'stvo 'Lesnaja Promyslennost'', Moscow. pp. 98. [28 refs. [Ru.] N.L.L.]
A compilation of information on the tree dimensions, and wood structure, defects, and physical and mechanical properties, of the main forest tree species of the region including Populus spp.

Sacre, E. 1974. [STUDY OF THE WOOD OF POPULUS 'I-214', P. 'ROBUSTA' AND P. 'GELRICA'. PART 2.] Bulletin de la Societe Royale Forestiere de Belgique 81 (4): 219-230 [F.nl., 1 ref.]
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811 STRUCTURE. IDENTIFICATION

Anonymous. 1968. [ANATOMICAL RESEARCH ON DIMENSIONS OF LIBRIFORM FIBRES IN THREE POPLAR STEMS.] Report H 68-87 Houtinstituut TNO (Forest Products Research Institute TNO), Delft. [Du.]

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Babos, K. 1968. [RELATIONS BETWEEN ANATOMICAL AND PHYSICO-MECHANICAL CHARACTERS IN POPULUS 'ROBUSTA'.] Faip. Kutatas., Budapest (1), (283-93). [7 refs. [Hu.hu.ru. e.g.] P.R.]
Distribution curves of fibre lengths are given: for narrow, medium and wide annual rings (of the first 10 and of the first 20 years) of Populus 'Robusta', P. 'Marilandica', and P. 'Serotina'; and, for P. 'Robusta' only, studies of changes of fibre length within rings. Fibre length increased from early to late wood, largely in parallel with density.

Babos, K. 1970. [FIBRE LENGTH AND DENSITY DISTRIBUTION WITHIN THE ANNUAL RINGS OF POPULUS X ROBUSTA.] Holztechnol. 11 (3): 188-92. [G.e.ru., 10 refs. P.R.]
Measurements on material from 24 annual rings from a disc of P. X robusta showed that there is a regular increase in fibre length and wood density within the ring from early wood to late wood. Fibre length increases rapidly during the first ten years of growth and afterwards more slowly. Increase in density is the result of the increase in fibre length and fibre tissue volume.

Babos, K., and Fillo, Z. 1970. [RELATION OF THE FIBRE-LENGTH DISTRIBUTION TO ANNUAL-RING WIDTH FOR DIFFERENT VARIETIES OF POPLAR.] Holztechnol. 11 (2): 91-3. [G.e.ru., 4 refs. P.R.]
Fibre-length measurements were made on individual growth rings from 48 stems of three varieties of Populus X canadensis (vars. marilandica, serotina and robusta) from three different sites. The mean fibre length is smaller in wide than in narrow rings on account of the larger volume of early wood. Fibre length follows a normal distribution in medium and wide rings, but is less regular in narrow rings. The greatest mean fibre length is reached in trees that produce a high proportion of average and narrow rings during their whole growth period.

Braun, H. J. 1967. [DEVELOPMENT AND STRUCTURE OF WOOD RAYS WITH SPECIAL REFERENCE TO THE CONTACT/ISOLATION DIFFERENTIATION IN RELATION TO THE HYDROSYSTEM. I. THE PRINCIPLE OF CONTACT/ISOLATION DIFFERENTIATION.] Holzforschung. Berlin 21 (2): 33-7. [22 refs. [G.g.e.] P.R.]
Discusses the development and structure of: (a) upright (long axis vertical and (b) procumbent (long axis radial) 'contact cells', and (c) procumbent 'isolation cells'. The rays of Populus sp. develop (b) first and later also (c).

Clement, A., and Janin, G. 1973. [FURTHER STUDY ON THE PRESENCE OF $CaCO_3$ CRYSTALS IN POPLAR WOOD. EXISTENCE OF FIVE ZONES RECOGNIZED BY THEIR P CONTENT.] Annales des Sciences Forestieres 30 (1): 63-81 [F.e.de.it., 14 ref.]
A study on 28 Poplar species, varieties, hybrids etc. confirmed earlier evidence that $CaCO_3$ crystals occur in Poplars of sections Aigeiros, Leucoides and Tacamahaca and in their hybrids, but not in Poplars of section Leuce. Five wood zones in P. trichocarpa 'Fritzi Pauley' are distinguishable by their P content: crown wood; peripheral wood; sapwood; heartwood; and core wood.

Ganchev, P. 1971. [STUDIES ON THE ANATOMICAL STRUCTURE OF THE WOOD OF SOME HYBRID BLACK POPLAR VARIETIES.] Gorskostopanska Nauka 8 (4): 15-22 [Bulg.ru.e., 8 ref.]
Gives data for wood of 8-year trees of Populus 'I-214', P. 'Weltheimeipappel', P. 'B-6', P. 'Bachelieri', P. 'Vernirubens', P. 'Gelrica', and P. 'Regenerata' grown in Bulgaria. Fibre length was greatest in P. 'Bachelieri' and P. 'Regenerata'.

Griffioen, K. 1972. [SOME ANATOMICAL, PHYSICAL AND MECHANICAL PROPERTIES OF POPULUS 'GELRICA', P. 'DORSKAMP' AND P. 'OXFORD'.] Populier 9 (2): 26-32 [Nl.e.]
Gives data from a study on wood from 3 stems each of P. 'Gelrica', 21 years old, and P. 'Dorskamp' and P. 'Oxford', 11 years old. The data are compared with those already published for P. 'Robusta'.

Itoh, T. 1974. FINE STRUCTURE OF SECONDARY WALL THICKENING AND A ROLE OF MICROTUBULES IN PRIMARY XYLEM CELLS OF POPLAR. Wood Research 57: 48-69 [E., 52 ref.]
Secondary wall thickening and organization of the cytoplasm during the development of primary xylem cells in young Poplar shoots were studied.

Itoh, T. 1974. FINE STRUCTURE OF THE MEMBRANES AND ORGANELLES IN PARENCHYMA CELLS OF POPLAR SHOOT OBSERVED BY FREEZE ETCHING TECHNIQUE. Wood Research 57: 31-47 [E., 22 ref.]
The distribution of very small particles (average diameter ca. 110 Å)

on both convex and concave planes of almost all the membranes and organelles of parenchyma cells in actively growing young Poplar shoots is described and illustrated with photomicrographs.

Kolarov, D. 1974. [EFFECT OF SITE TYPE ON THE ANATOMICAL STRUCTURE OF THE WOOD OF HYBRID BLACK POPLAR CLONES.] Gorskostopanska Nauka 11 (6): 17-26. [Bulg.ru.de., 16 ref.]
Compares the wood anatomy of Populus 'I-214', P. 'Regenerata', P. 'Vernirubens' and P. 'Bachelieri' in plantations 10 years old on a typical Poplar site (flood-plain alluvial).

Laming, P. B., Welle, B. J. H., ter, and Griffioen, K. 1972. [SOME MARGINAL NOTES ON ANATOMICAL CHARACTERISTICS OF JUVENILE WOOD OF POPLAR.] Populier 9 (1): 13-16. [Du.]

Mutibaric, J. 1968. COMPARATIVE QUALITIES OF EURAMERICAN POPLARS: DIMENSIONS OF WOOD FIBRES AND SPECIFIC GRAVITY. [Docum.] 13th Sess. Int. Poplar Comm., Montreal 1968 No. FO:CIP/13/26, pp. 15. [9 refs.]
Discusses fiber morphology and density (at ages 2 to 6) of 8 cultivars grown on alluvial soils in the Danube bottomland. These characteristics are controlled by heredity and the effects of environment are negligible.

Mutibaric, J. 1969. PRELIMINARY RESULTS OF RESEARCH INTO THE CHARACTERISTICS (DENSITY AND WOOD FIBER LENGTH) OF JUVENILE WOOD OF SOME EURAMERICAN POPLARS. [Pap.] 2nd FAO/IUFRO World Consult. For. Tree Breed., Washington 1969 No. FO-FTB-69-4/8, pp. 3 + smry. [2 refs. [E.e.].]
In trials on alluvial soils in a depression and on a raised site in Jugoslavia, the mean fibre length at 5 years was significantly greater (by 2%), and the density lower, on the depressed sites.

Patel, R. N. 1965. A COMPARISON OF THE ANATOMY OF THE SECONDARY XYLEM IN ROOTS AND STEMS. Holzforschung, Berlin 19 (3): 72-9. 18 refs. [E.e.g.] P.R.
A comparison was made between the wood of tap-root and lateral roots and that of the main stem in two ring-porous and three diffuse-porous species. Ring-porousness was absent from or not clearly defined in the roots of ring-porous species. In Poplar and Alder, radial pore multiples were more frequent in the stem than in the root.

Stahel, J. 1968. [QUANTITATIVE AND QUALITATIVE AGEING PHENOMENA IN POPLAR (POPULUS 'ROBUSTA').] Holz Roh- u. Werkstoff 26 (11): 418-27. [30 refs. [G.g.e.] P.R.]
Study of 1-, 17- and 27-year-old stems showed that cambial production of phloem starts earlier in the older stems but persists longer in the youngest.

Tocan, M., Popa, V., and Cretu, I. 1970. [MICROSCOPIC STRUCTURE OF RUMANIAN POPLAR WOOD.] Celuloza si Hirtie 19 (10): 347-353 [Ru., 13 ref.] From Cellulosa e Carta (1972) 23 (4) 69. [It.]
Morphological aspects of the structure of the cell-walls of fibres in normal wood and tension wood of Poplars, at different heights in the stem, were analyzed by electron microscope. The structure, crystalline state and orientation of the fibres in normal wood and tension wood were studied by means of X-rays.

Zarhina, E. S. 1969. [FIBRE DIMENSIONS OF POPLARS IN THE AMUR REGION.] Lesn. Z. 12 (6): 149-50. [Ru.]
Tabulates data on fibre length in 1-year shoots of 18 species and hybrids, and at mid-height in 4- to 6-year trees of 11 species and hybrids growing on heavy meadow soil and/or light alluvial soil. Soil type did not appear to affect fibre length.

Zenker, R. 1968. [TENSION-WOOD PERCENT AND FIBRE LENGTH IN THE STEMWOOD OF DIFFERENT POPLAR VARIETIES.] Faserforschung und Textiltechnik, Berlin 19 (1): 1-10. [14 refs. [G.g.ru.e.] N.L.L.]
Mean tension wood (t.w.) % ranged from 4·1 for P. trichocarpa to 30·3% (P. X robusta), the lower values being more frequent. T.w.% increased with height on stem and was greatest in the W. and N. aspects. Mean fibre length (f.l.) varied from 0·909 ('Harff') to 1·153 mm. Both f.l. and t.w. were weakly correlated with the wood density and growth rate of varieties.

Bohlmann, D. 1970. [ANATOMICAL AND HISTOLOGICAL STUDIES OF THE NODAL AREAS AT BRANCH JUNCTIONS IN CONIFERS AND HARDWOODS. III. THE NODAL AREAS IN QUERCUS ROBUR AND POPULUS SECTION AIGEIROS.] Allg Forst- u. Jagdztg. 141 (11): 224-30. [G.e.f., 6 refs.]
Describes in detail, with illustrations, the nodal areas in Quercus robur and, very briefly, those in Poplars, which differ only in details.

Buczacki, S. T. 1973. XYLEM FLECKS: A NOTE ON SOME UNEXPLAINED ABNORMALITIES IN THE WOOD OF EUROPEAN LARCH AND OTHER TREES. New Phytologist 72 (4): 825-831 + 1 pl. [E., 9 ref. OBD]
Xylem flecks were found in several other species including Populus X euramericana.

Casperson, G., and Hoyme, E. 1964. [CELLWALL FORMATION IN DECIDUOUS TREES. 3. THE BORDER OF THE LUMEN IN REACTION WOOD.] Faserforschung und Textiltechnik, Berlin 15 (5): 205-10. [41 refs. [G.g.ru.e.] N.L.L.]
In Quercus robur, the layer between G-layer and lumen appeared to be a true tertiary lamella, and was sometimes lignified. In Populus sp., the border layer may be identical with a tertiary lamella, and contained pectin.

Fujita, M., Saiki, H., and Harada, H. 1974. [ELECTRON MICROSCOPY OF MICROTUBULES AND CELLULOSE MICROFIBRILS IN SECONDARY WALL FORMATION OF POPLAR TENSION WOOD FIBERS.] Mokuzai Gakkaishi (Journal of the Japan Wood Research Society) 20 (4): 147-156 [E.jap., 32 ref. BLL]
Optical and transmission electron microscopy were employed to examine the shape and location of microtubules in differentiating gelatinous fibres of Poplar tension wood.

Furuya, N., Takahashi, S., and Miyazaki, M. 1970. [THE CHEMICAL COMPOSITION OF THE GELATINOUS LAYER FROM THE TENSION WOOD OF POPULUS EUROAMERICANA.] J. Jap. Wood Res. Soc. 16 (1): 26-30. [Jap.e., 23 refs. P.R.]
The gelatinous layer was separated by ultrasonic treatment of thin sections and examined by chemical analysis and acid hydrolysis. It consists primarily of cellulose together with pectic materials and other polysaccharides, and has a high ash content. Pectic materials are distributed throughout the layer.

Harada, H., Taniguchi, T., and Kishi, A. 1971. [ULTRASTRUCTURE OF THE GELATINOUS LAYER IN TENSION-WOOD FIBRES FROM POPULUS EURAMERICANA.] Bull. Kyoto Univ. For. No. 42 (221-7). [Jap.e., 9 ref.]
Describes and illustrates with photomicrographs a study of tension-wood fibres of P. X euramericana [P. X canadensis] by electron microscopic, X-ray diffraction and infra-red spectroscopic techniques.

Mia, A. J. 1967. FINE STRUCTURE OF GELATINOUS LAYER IN TENSION WOOD FIBRES OF POPULUS. Abstr. in Amer. J. Bot. 54 (5, Part 2), (643). [O.B.D.]
The author proposes a new wall model for the G layer in which random cellulose microfibrils are oriented ∥ to one another at a steep angle to the longitudinal fibre axis.

Muller-Stoll, W. R., and Zenker, R. 1967. [INVESTIGATIONS ON THE FREQUENCY AND DISTRIBUTION OF TENSION WOOD IN POPLAR STEMS.] Holz Roh- u. Werkstoff 25 (7): 245-54. [13 refs. [G.g.e.] P.R.]
Studies were made in N. Germany on 12 straight-grown stems of three Poplar hybrids.

Nobuchi, T., and Fujita, M. 1972. CYTOLOGICAL STRUCTURE OF DIFFERENTIATING TENSION WOOD FIBRES OF POPULUS EUROAMERICANA [P. X CANADENSIS.] Mokuzai Gakkaishi (Journal of the Japan Wood Research Society) 18 (3): 137-144 [E.jap., 14 ref. PR]
Reports a study, illustrated by light and electron micrographs, of cell-wall formation in tension-wood fibres of Poplar.

Sachsse, H. 1964. [SUBMICROSCOPIC STRUCTURE OF THE FIBRE CELL-WALL IN POPLAR TENSION-WOOD.] Holz Roh- u. Werkstoff 22 (5): 169-74. 9 refs. [G.g.e.] P.R.

Confirms earlier findings and discusses the methods used to establish that the honeycomb structure of the gelatinous layer is not an artifact of the preparation.

Sachsse, H. 1965. [PROPERTIES AND FUNCTIONING OF TENSION WOOD IN BROADLEAVED SPECIES.] SchrReihe Forstl. Fak. Univ. Gottingen 35, pp. 110. 105 refs. [G.g.e.]
Includes a detailed discussion of the literature and reports on the author's studies.

Sachsse, H. 1965. [THE SUBMICROSCOPIC STRUCTURE OF THE FIBRE CELL WALL IN POPLAR TENSION WOOD. Transl. Commonw. Sci. Industr. Res. Organ. Aust. No. 7127, pp. 9. 9 refs. Transl. by M. Godfrey from Holz Roh- u. Werkstoff 22 (5), 1964 169-74).

811.22

Patscheke, G., and Zenker, R. 1970. [RELATIONSHIPS BETWEEN THE CONTENTS OF CELLULOSE AND TENSION WOOD IN POPLAR.] Faserforsch & Textiltech 21 (8): 332-338. [G.]

811.5

Janin, G., and Clement, A. 1972. [EVIDENCE FOR THE PRESENCE OF CALCIUM CARBONATE CRYSTALS IN POPLAR WOOD ATTRIBUTABLE TO THE DISTRIBUTION OF MINERALS DURING THE FORMATION OF HEARTWOOD.] Annales des Sciences Forestieres 29 (1): 67-105 [F.e.de.it., 13 ref.]
A study of the presence of crystals in the wood of both young and mature Poplars was undertaken after crystals were discovered by visual examination and densitometric scanning of X-ray photos of increment cores of Populus trichocarpa.

Sachsse, H. 1967. [THE WATER/GAS RATIO WITHIN THE PORE SPACE OF WOOD OF LIVING TREES, WITH REGARD TO HEARTWOOD FORMATION.] Holz Roh- u. Werkstoff 25 (8): 291-303. [25 refs. [G.g.e.] P.R.]
Investigations were made on Populus X robusta and Fagus sylvatica to determine whether a relationship exists between wood moisture content and the initiation of heartwood formation. The ratios of free water to gas within the pore space were determined at different seasons.

Sachsse, H. 1967. [THE WATER/GAS RATIO WITHIN THE PORE SPACE OF WOOD, WITH REGARD TO HEARTWOOD FORMATION (STUDIED IN POPULUS CV. 'ROBUSTA').] Proc. 14th Congr. Int. Union For. Res. Organ., Munich 1967 Pt. IX, Sect. 41, (70-92). [21 refs. [G.g.] 6 gphs. 1 tbl.]

811.7

Bosshard, H. H., and Stahel, J. 1969. [MODIFICATIONS IN THE SECONDARY BARK OF POPULUS X ROBUSTA.] Holzforsch. u. Holzverwert., Wien 21 (5): 109-13. [12 refs. [G.g.e.] P.R.]
Qualitative ageing in the phloem was studied by measuring the degree of slenderness of ray cell nuclei. It was found that the phloem zone near the cambium is just as active as the xylem zone near the cambium.

Fillo, Z. 1969. [A NEW METHOD FOR SPECIES IDENTIFICATION OF NATIVE POPLAR AND BLACK POPLAR HYBRIDS.] Faipar, Budapest 19 (2), (54-8). [Hu. From asbstr. in Hu. agric. Rev. 1970 19 (2), (No. 352) C.G.B.]
Populus 'Marilandica', P. 'I-214', P. 'Robusta', P. 'H-422' (P. alba X P. grandidentata) P. nigra and P. tremula showed characteristic differences in bark anatomy.

Fillo, Z. 1973. [THE BARK ANATOMY OF THE INDUSTRIALLY MORE IMPORTANT SPECIES OF NATIVE AND HYBRID POPLARS IN HUNGARY.] In Faipari Kutatasok 1972. 265-278 + 12 pl., 1 tbl. [Hu.ru.e.de., 4 ref. TRADA]
Presents coloured photos and photomicrographs of cross-sections of the bark of Populus alba, P. canescens, P. nigra, P. tremula, and the hybrids P. 'Marilandica', P. 'Robusta', P. 'Gelrica', P. 'I-214' and P. 'H-381', with notes on each and a key for the identification of species in this group from macroscopic bark characters.

Nanko, H., Saiki, H., and Harada, H. 1974. [STRUCTURE AND DEVELOPMENT OF THE SECONDARY PHLOEM IN POPULUS EURAMERICANA GUINIER.] Bulletin of the Kyoto University Forests No. 46, 179-189 [Jap.e., 10 ref.]

Reports the results of a study, illustrated with photomicrographs of thin wood sections of P. X euramericana [P. X canadensis, cultivar not specified], on the development of the secondary phloem in Poplar wood, and on the morphological changes that occur when the phloem matures.

Sachsse, H. 1969. [ON THE SEASONAL VARIATIONS OF MOISTURE CONTENT IN THE BARK OF LIVING POPLAR (POPULUS 'ROBUSTA').] Holz Roh- u. Werkstoff 27 (2): 55-66. [26 refs. [G.g.e.] P.R.]
Observations on m.c., sp.gr. and volume shrinkage were made for a year at monthly intervals on 25-mm.-diam. cores from twenty 12-year-old stems cut out with a cylindrical saw held in an electric hand drill and powered by a portable generator.

812 PHYSICAL AND MECHANICAL PROPERTIES

Anonymous. 1970. [SOME PHYSICAL AND OTHER CHARACTERISTICS OF THREE POPULUS 'DORSKAMP' STEMS.] Report H 70-142 Houtinstituut TNO (Forest Products Research Institute TNO), Delft. [Du.]

Anonymous. 1970. [SOME PHYSICAL AND OTHER PROPERTIES OF THREE POPULUS 'GELRICA' STEMS.] Report H 70-7 Houtinstituut TNO (Forest Products Research Institute TNO), Delft. [Du.]

Anonymous. 1971. [RESEARCH ON SOME PROPERTIES OF SEVEN POPLAR CULTIVARS.] Report H 71-11 Houtinstituut TNO (Forest Products Research Institute TNO), Delft. [Du.]

Anonymous. 1974. [ORIENTATION ON THE DETERMINATION OF THE BASIC DENSITY OF INCREMENT BORER CORES IN POPLARS.] Report H 74-27 Houtinstituut TNO (Forest Products Research Institute TNO), Delft. [Du.]

Anonymous. 1974. [INITIAL RESEARCH INTO THE RELATION BETWEEN THE AVERAGE BASIC DENSITY OF THE ENTIRE STEM OF POPLAR AND THAT OF INCREMENT BORER CORES TAKEN AT BREAST HEIGHT.] Report H 74-133 Houtinstituut TNO (Forest Products Research Institute TNO), Delft. [Du.]

Encev, E. A., Stojanov, V., and Stojkov, H. 1970. [COMPARATIVE STUDIES ON THE PHYSICAL AND MECHANICAL PROPERTIES OF POPLAR WOOD FROM STEMS OF DIFFERENT AGE.] Gorskostop. Nauka 7 (5): 53-61. [Bulg.ru.g., 2 refs.]
Tabulates data on the density, and the compression and bending strengths, of air-dry wood of 8 hybrid Black Poplar clones aged 4 and 8 years.

Griffioen, K. 1973. [INVESTIGATION ON THE PROPERTIES OF POPLAR WOOD.] Populier 10 (2): 45-49. [Du.E.f.]

Kepsta, D. 1970. [CAN THE DRYING CHECKS IN POPLAR SAWN WOOD BE REDUCED?] Drevo 25 (4): 93-95. [Cz.]

Rangelov, K. 1965. [PROPERTIES OF POPULUS X REGENERATA HEARTWOOD.] Gorsko Stopanstvo 21 (7): 11-6. [Bulg.]
Tabulates and graphs data on the physical and mechanical properties of sapwood and heartwood at different heights in the stems of trees aged 13-14 and 20 years, from two different sites in Bulgaria.

Simpson, W. T. 1974. MEASURING DEPENDENCE OF DIFFUSION COEFFICIENT OF WOOD ON MOISTURE CONCENTRATION BY ADSORPTION EXPERIMENTS. Wood Fibre 5 (4): 299-307.

Stojanov, V., and Encev, E. A. 1969. [WOOD PROPERTIES OF SOME POPLAR HYBRIDS IN THE POPLAR TRIAL AREA NEAR JAMBOL [BULGARIA].] Gorskostop. Nauka, Sofija 6 (2): 51-7. [7 refs. [Bulg.ru.g.].]
Tabulates data on the physical and mechanical properties of wood from 6-year Populus rasumowskiana X P. canadensis, P. rasumowskiana X P. laurifolia, P. rasumowskiana X P. pyramidalis, P. canadensis B 12, P. vernirubens, and P. regenerata.

812.1

Fabian, T. 1972. [FIRE PROTECTION STUDIES ON BUILDINGS OF WOOD AND WOOD-BASED MATERIALS.] Faipari Kutatasok, publ. pp. 267-291. [Hu.ru.e.de., 16 ref.]

Laughren, T. P., and Hann, R. A. 1965. POSSIBLE APPLICATIONS OF RADIATION PYROMETRY IN WOOD PROCESSING. For. Prod. J. 15 (1): 31-2. 1 ref.
Suggests that pyrometers (which determine surface temperature by measuring the intensity of infra-red radiation emitted) could be used for monitoring surface temperaturs in driers or presses.

Necesany, V. 1971. THE ISOELECTRIC POINT OF LIGNIFIED CELL-WALLS. Holz Roh- u. Werkstoff 29 (9): 354-7. [E.de., 6 ref. PR]
The isoelectric point of wood cell-walls of Beech and Poplar in their natural condition and after removal of pectin, lignin or hemicellulose was measured by a method involving the fluorescent coloration of acridine orange in a phosphate buffer of graded pH.

812.2

Palovic, J., and Krutel, F. 1972. [DIMENSIONAL STABILITY OF POPLAR IN COMPARISON WITH CONIFERS.] Zbornik Vedeckych Prac Drevarskej Fakulty Vysokej Skoly Lesnichej a Drevarskej vo Zvolene pp. 37-63 [Sk.ru.de., 11 ref.]
Presents and discusses detailed results from studies made on a total of 900 pieces of dimension stock of different sizes to compare Poplar with Norway Spruce, Silver Fir and Scots Pine.

Rangelov, K. 1965. [MOISTURE CONTENT OF SAPWOOD AND HEARTWOOD OF POPULUS X REGENERATA STEMS.] Gorsko Stopanstvo 21 (10); 4-6. [Bulg.]
Tabulates and graphs data for various heights in freshly felled stems of trees aged 13-14 years.

Red'ko, G. I. 1964. [THE MOISTURE CONTENT OF SAPWOOD AND HEARTWOOD OF POPLAR.] Lesn. Z., Arhangel'sk 7 (2): 132-6. 4 refs. [Ru.]
Shows, in tables and graphs, the m.c. of freshly cut sapwood and heartwood of 7 Poplar species and hybrids growing on different site types.

812.3

Ghisi, G. 1969. [A COMPARISON OF SOME METHODS OF DETERMINING THE BASIC DENSITY OF POPLAR WOOD FOR INDUSTRIAL USE.] Pubbl. Cent. Sper. Agric. For. 10 (3): 239-48. [It.e., 1 ref.]
A comparison was made of three direct methods of determining the basic density of disks cut from Poplar stems, by water immersion and two methods of geometrical measurement, and of one indirect method by removing four increment cores from the disks along radii at right angles to each other and measuring them either by immersion or geometrically.

Gotze, H. 1964. [A STUDY OF DENSITY IN POPLAR WOOD.] Arch. Forstw. 13 (11): 1193-1214. 26 refs. [G.g.ru.e.]
A study based chiefly on 15 stems of each of 9 varieties (mostly Black Poplar hybrids), aged 19-46 years, from three E. German sites.

Gotze, H. 1968. [THE CHANGE IN DENSITY ALONG AND ACROSS THE STEM IN VARIOUS POPLARS.] Drev. Vyskum (3): 115-32. [11 refs. [G.slovak.e.ru.] P.R.]
Observations of oven-dry density were made on each growth ring across N. S. and E.-W. disc diameters of up to four 15-year-old stems each of 15 kinds of Poplar from the Krummer Pfuhl Poplar research area in E. Germany.

Gotze, H. 1968. [SPECIFIC GRAVITY OF WOOD FROM DIFFERENT POPLAR VARIETIES GROWN ON THE 'KRUMMER PFUHL' TRIAL PLOT NEAR WALDSIEVERSDORF.] Arch. Forstw. 17 (5): 483-500. [6 refs. [G.g.e.ru.].]
Oven-dry density and its variability within and between stems and varieties was studied on 36 stems of 15 varieties from one trial plot, aged 15 years.

Hamilton, J. R., and Wendel, G. W. 1967. SPECIFIC GRAVITY AND FIBER LENGTH OF SOME HYBRID POPLARS GROWING IN WEST VIRGINIA. Bull. W. Va. Agric. Exp. Sta. No. 556T, pp. 6. [11 refs.]
Tabulates and discusses data on sp.gr., fibre length, mean d.b.h. and mean total height ca. 15 years after planting, of 13 selected clones near Parons, West Virginia.

Mutibaric, J. 1967. [CORRELATION BETWEEN RING WIDTH AND WOOD DENSITY IN EURAMERICAN POPLARS.] Sumarstvo 20 (1/2): 39-46. [13 refs. [Serb.e.].]
Gives data from studies on 5 Populus X robusta and 5 P. X marilandica, all aged 14-16 years, growing in Jugoslavia. For both species, basic density and density at 12% moisture content decreased slightly with increasing ring width. In all cases, differences were significant at the 1% level.

Scaramuzzi, G. 1967. [COMPARISON OF SOME METHODS OF DETERMINING THE BASIC DENSITY OF INCREMENT CORES OF POPLAR.] Pubbl. Cent. Sper. Agric. For., Roma 9 (3): 221-34. [41 refs. [It.it.e.e.].]
Methods compared were (a) immersion in water, (b) maximum moisture, (c) borer diameter (or calibrated borer), and (d) core diameter.

Scaramuzzi, G. 1969. [ESTIMATION OF WOOD DENSITY OF STANDING TREES OF POPLAR FROM CORE SAMPLES.] Pubbl. Cent. Sper. Agric. For. 10 (3): 213-37. [It.e., 36 refs.]
Gives the results of a study of the use of different relationships in the estimation of wood density in Poplar trees 11-13 years old and of 24-40 cm. d.b.h. and 16-26 m. merchantable height.

Scaramuzzi, G., and Ferrari, G. 1964. RELATION OF WOOD DENSITY TO WOOD STRUCTURE IN POPULUS. News Bull. Int. Ass. Wood Anatomists (1): 2-4.
Summarizes the results of investigations carried out at the Centro di Sperimentazione Agricola e Forestale of the E.N.C.C., Rome, on wood from a total of 25 trees (age 9-38), including Populus tremula, 5 cultivars of P. X canadensis, and 2 of P. deltoides.

Scaramuzzi, G., and Ferrari, G. 1973. [EVALUATION OF THE CHARACTERISTICS OF WOOD OF STANDING POPLAR TREES BY NON-DESTRUCTIVE METHODS. 1 – BASIC DENSITY.] Pubblicazioni del Centro di Sperimentazione Agricola e Forestale 12: 181-201 [It.e., 36 ref.]
The estimation of basic density for whole stems and stem sections from paired b.-h. increment cores was studied in 77 Populus X euramericana [P. X canadensis] trees 4-12 years old, belonging to 37 clones.

Vivani, W. 1969. [PRIME OBSERVATION COLLECTED ON THE BEHAVIOR OF SIX NEW CLONES OF POPLAR FOR THE MANUFACTURE OF PLYWOOD.] Agr. Venezie 23 (3): 195-197. [It.]

Stojanov, V., and Encev, E. A. 1970. [PHYSICAL AND MECHANICAL PROPERTIES OF THE WOOD OF SOME BULGARIAN AND EXOTIC POPLAR HYBRIDS CULTIVATED ON TYPICAL POPLAR SITES.] Gorskostop. Nauka 7 (2): 47-53. [Bulg.ru.e.g., 6 refs.]
Tabulates data on density and mechanical properties for wood of Populus alba X P. tremula (groups 444, 445, and 446), and P. X regenerata, all aged 6 years, and P. [nigra var.] italica, P. 'Serotina Belenska', and P. rasumowskyana X P. pyramidalis 73/30 B 48, all aged 14 years.

812.7

Ahlborn, M. 1964. [THE STRENGTH OF THE MECHANICAL TISSUE OF GERMAN HARDWOODS (POPULUS X ROBUSTA).] Holzforschung, Berlin 18 (5): 129-39. 55 refs. [G.g.e.] P.R.
Presents the chief parts of this thesis, published in full with only limited distribution.

Gotze, H. 1964. [STRENGTH OF POPLAR WOOD IN COMPRESSION, TENSION, AND BENDING.] Holztechnol., Dresden 5 (2): 121-31. 23 refs. [G.g.ru.e.] P.R.
The main study discusses strength properties in relation to density for stemwood of Populus X regenerata and P. X marilandica from five E. German sites.

Lubardic, S. 1967. [NAIL AND SCREW WITHDRAWAL RESISTANCE OF THE WOOD OF SOME POPLARS.] Sumarstvo 20 (1/2): 21-8. [4 refs. [Serb.e.].]
Studies on Populus X serotina, P. X robusta and P. X marilandica showed that withdrawal resistance was greater in the radial and tangential than in the axial direction. Nail withdrawal resistance was greater in the denser woods (P. X serotina and P. X robusta) than in P. X marilandica, but screw withdrawal resistance did not appear to be related to wood density.

Mutibaric, J. 1968. [THE NAIL-HOLDING PROPERTIES OF [WOOD OF] SOME HYBRID BLACK POPLARS AND OF SALIX ALBA.] Sum. List 92 (9/10): 345-56. [5 refs. [Serb.e.e.].]
Presents the results of A.S.T.M. tests of wood (moisture content 5·48-6·73%) from 14- to 16-year-old Populus X robusta, P. X marilandica, and P. X serotina, and from 38- to 42-year-old S. alba from the Sombor.

Petit, Vergara, J., and Perez Galaz, A. 1972. [JOINTS IN STRUCTURAL TIMBER : NAILS AND SCREWS.] Informe Tecnico, Instituto Forestal, Chile No. 36, 213-220 [Es.]
Gives results of nail-withdrawal tests (7 sizes of nails) with Poplar [unspecified], Pinus radiata, Nothofagus dombeyi, Araucaria araucana, and Laurel [unspecified].

Saiki, H., Furukawa, I., and Harada, H. 1972. [AN OBSERVATION ON TENSILE FRACTURE OF WOOD BY SCANNING ELECTRON MICROSCOPE.] Bulletin of the Kyoto University Forests No. 43, 309-319 [Jap.e., 13 ref.]
Describes in detail, and illustrates with photomicrographs, the structural features of ruptured cell-walls in beams of air-dry wood of Cryptomeria japonica, Pinus densiflora, Fraxinus spacthiana and Populus X euramericana [P. X canadensis] broken in tension.

813 WOOD CHEMISTRY

Hnidei, L. 1970. [THE CHEMICAL STUDY OF POPLAR IN THE ROMANIAN SOCIALIST REPUBLIC. III. NORMAL WOOD AND REACTION WOOD.] Celuloza Hirtie 19 (6): 193-196. [Rum.]

Jo, S. H., N. S. Jo, and J. H. Kim. 1973. STUDIES ON THE CHEMICAL COMPONENT OF COMMERCIAL WOODS IN KOREA (REPORT 2) – CHEMICAL COMPONENT OF GENUS POPULUS IN KOREA. Res. Rep. For. Res. Inst. No. 20, 115-118.

Jokel, J. 1970. [THE FORMATION OF FREE RADICALS IN WOOD AFTER IRRADIATION.] Drev. Vyskum (3), (93-101). [Slovak.ru.g.e., 15 refs. P.R.]

Kuvaev, M. M., Nemirovskii, V. D., Sokolova, I. V., Egorov, A. E., and Chudakov, M. I. 1973. [ANALYSIS OF PRODUCTS FROM OXIDATION OF POPULUS LIGNIN.] Gidroliz Lesokhim Prom-st' 4: 3-5. [Ru.]

Lawniczak, M. 1972. [EFFECT OF MODIFYING POPLAR WOOD WITH ISOCYANATES ON SOME OF ITS PROPERTIES.] Folia Forestalia Polonica, B No. 11, 67-82 [Pol.ru.e., 6 ref.]

Rozmarin, G., and Popa-Stoicescu, M. 1972. [THE THERMODESTRUCTION OF POPLAR AND ITS CHEMICAL COMPONENTS.] Celuloza Hirtie 21 (3): 145-153. [Rum.e.]

Simionescu, C., and Corlateanu, E. 1970. [STUDY OF FIBROUS CELLULOSIC MATERIAL. THE FLUFF OF POPLAR TREES.] Cellul. Chem. Technol. 4 (2): 165-193. [F.]

Simionescu, C., and Coralateanu, E. 1971. [STRUCTURA SUPRAMOLECULARA A CELULOZEI; STUDY OF SOME NEW FIBROUS CELLULOSIC MATERIAL: FLUFFY MASS OF POPLAR. 3. SUPRAMOLECULAR STRUCTURE OF THE PULP.] Celuloza Hirtie 20 (3): 108-118. [Rum.e.]

Simionescu, C., Rozmarin, G., Cernatescu-Asandei, A., and Popa-Stoicescu, M. 1972. [THE STUDY OF THE RADIOLYTICAL MODIFICATIONS OF THE POPLAR WOOD AND ITS CHEMICAL COMPOSITION.] Celuloza Hirtie 21 (7): 370-376. [Rum.e.]

Zalasky, H. 1972. ISOLATION AND CHARACTERISTICS OF SCLERIDLIKE CELLS IN SAPWOOD OF PINUS AND POPULUS. Information Report, Northern Forest Research Centre, Canada, No. NOR-X-48, 14 pp. [E., 13 ref.]

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Anonymous. 1965. [CHEMISTRY AND BIOCHEMISTRY OF LIGNIN, CELLULOSE, AND HEMICELLULOSES.] Proceedings of the International Symposium at Grenoble, July 1964.] Imprimeries Reunies, Chambery. pp. 509. Many refs. [F.G.E.] P.R.

Anonymous. 1971. [CHEMICAL STUDY OF POPLAR IN THE RUMANIAN SOCIALIST REPUBLIC. V. PHYSICAL CHEMISTRY OF POPLAR LIGNIN.] Celuloza si Hirtie 20 (6): 261-265. [Rum.]

Ferrari, G. 1967. WITHIN-TREE VARIATION OF WOOD CHEMICAL COMPOSITION IN POPULUS X EURAMERICANA. Proc. 14th Congr. Int. Union For. Res. Organ., Munich 1967 Pt. IX, Sect. 41, (300-24). [32 refs. [E.e.].]
Reviews the literature and presents results of an investigation on changes in the main cell-wall constituents of three 18-year-old P. X euramericana from a stand near Rome.

Ferrari, G. 1968. [VARIATIONS IN THE CHEMICAL COMPOSITION OF WOOD WITHIN THE STEM, IN POPULUS X EURAMERICANA.] Pubbl. Cent. Sper. Agric. For., Roma 10 (1): 11-26. [30 refs. [It.it.e.e.].]

Fukuda, T., et al. 1969. [STUDIES ON THE ENZYME IN CAMBIAL ZONE. II. SEASONAL CHANGES IN THE ACTIVITIES OF PHENYLALANINE AMMONIA-LYASE AND PEROXIDASE, RATE OF GROWTH AND RATE OF LIGNIFICATION.] J. Jap. Wood Res. Soc. 15 (4): 182-7. [14 refs. [Jap.jap.e.] P.R.]
In Populus euroamerica[na] and Chamaecyparis obtusa the activity of phenylalanine ammonia-lyase in the cambial zone increases rapidly in early June, reaches a maximum at the end of June, then decreases. Peroxidase activity shows no significant changes. Rates of lignification and of growth of the same tissues follow the same pattern as the phenylalanine ammonia-lyase activity.

Giurcanu, C., and Anton, I. 1973. [A STUDY OF SOME METHODS OF DETERMINING THE LIGNIN CONTENT OF FIBROUS RAW MATERIALS AND SEMI-MANUFACTURED PRODUCTS FROM VARIOUS SOURCES.] Celuloza si Hirtie 22 (6): 233-236 + smries. [Ro.f.e.de.ru., 4 ref. BLL]

Mori, I., and Terashima, N. 1971. BIOSYNTHESIS OF P-HYDROXYBENZOIC ACID IN POPLAR LIGNIN. J. Jap. Wood Res. Soc. 17 (7): 311-2. [E., 5 ref. PR]
Possible biosynthetic pathways were examined by measuring the incorporation of radioactivity in p-hydroxybenzoic acid via specifically labelled precursors.

Petrov, S. A., and Rjazanceva, P. A. 1967. [GEOGRAPHICAL AND INDIVIDUAL VARIATION IN THE CELLULOSE CONTENT OF WOOD OF POPLARS IN KAZAKHSTAN.] Trudy Kazahskogo Naucno – Issledovatel'skogo Instituta Lesnogo Hozjajstva (6), (214-20). [Ru.]

Polcin, J., and Karhanek, M. 1964. [EFFECT OF IONIZING RADIATION ON WOOD: OBSERVATION OF THE MORPHOLOGICAL STRUCTURE WITH THE AID OF ELECTRON MICROSCOPY.] Holzforschung, Berlin 18 (4): 102-8. 17 refs. [G.g.e.] P.R.
Irradiation of Spruce, Beech, and Poplar wood with γ-rays (up to 5 X 10^7 rad) caused no significant changes on the cell-wall surface observable by electron microscopy. When irradiated wood was mechanically disintegrated, however, the morphological structure broke down rapidly.

Riscuta, S., and Sasu, C. 1971. [QUALITATIVE STUDY OF THE CHEMICAL COMPOSITION OF POPLAR SPECIES.] Bul. Inst. Polit. Brasov (Ser. B: Econ. for.) No. 13. (327-32). [Ro.e., 3 ref.]
The total yield and qualitative composition of sugars obtained by hydrolysis of wood (from one stem of Rumanian Populus 'Robusta' aged 19 years) with 5% H_2SO_4 differed between the N., S., E. and W. quarters of the stem and between sapwood and heartwood.

Saleh, T. M. 1966. RADIOAUTOGRAPHY OF PLANT TISSUES USING TRITIUM-LABELED LIGNIN PRECURSORS. Abstr. of thesis, in Dissert. Abstr. 27B (3), (660). [O.R.S.]
Tritiated precursors were applied under the bark, through needles, or through cut ends, and, after a period of metabolism, radioautograms were prepared for (a) Cottonwood, (b) Douglas Fir and (c) wheat.

Sandermann, W., Schlink, C., et al. 1970. [REACTIONS OF WOOD AND WOOD COMPONENTS WITH DICARBOXYLIC ACID ANHYDRIDES. II. THE REACTION OF SPRUCE WOOD AND CELLULOSE WITH MALEIC AND SUCCINIC ACID ANHYDRIDE.] Papier, Darmstadt 24 (4): 187-92. [G.e.f., 4 refs. P.O.]
Presents data on Spruce wood and recapitulates data on Poplar.

Shafizadeh, F., McGinnis, G. D., and Philpot, C. W. 1972. THERMAL DEGRADATION OF XYLAN AND RELATED MODEL COMPOUNDS. Carbohyd. Res. 25 (1): 23-33.

Shimada, M., Fushiki, H., and Higuchi, T. 1973. MECHANISM OF BIOCHEMICAL FORMATION OF THE METHOXYL GROUPS IN SOFTWOOD AND HARDWOOD LIGNINS. Mokuzai Gakkaishi (Journal of the Japan Wood Research Society) 19 (1): 13-21 [E.jap., 33 ref. PR]

Simionescu, C., Cernatescu-Asandei, A., Grigoras, M., and Rozmarin, G. 1971. [CHEMICAL STUDY OF POPLAR IN THE RUMANIAN SOCIALIST REPUBLIC. V. PHYSICAL CHEMISTRY OF POPLAR LIGNIN.] Celuloza si Hirtie 20 (6): 261-265 [Ro., 11 ref.]

Thieme, H., and Beneke, R. 1970. DIE PHENOLGLYKOSIDE DER SALICACEEN. 7. UBER DIE GLYKOSIDRUHRUNG EINHEIMISCHER BZW. IN MITTELEUROPA KULTIVIERTER POPULUSARTEN. Pharmazie, Berlin 25, 780-789. Ref. in Ber. Biochem. Biologie, Berlin 347 (1971), 4, S.356.

Venverloo, C. J. 1971. [THE LIGNIN OF POPULUS NIGRA L. CV. 'ITALICA' AND SOME OTHER SALICACCAE.] Holzforschung 25 (1): 18-24. [E.de., 13 ref. PR]
The proportions of syringaldehyde, vanillin and p-hydroxybenzoic acid formed on oxidation with nitrobenzene of lignin from various parts of the stem of the Lombardy Poplar (mature and young secondary xylem, primary xylem and spiral thickenings from primary xylem, phloem fibres, periderm, callus cultures and tracheids isolated from callus cultures) were determined.

813.2

Levitin, N. 1970. THE EXTRACTIVES OF BIRCH, ASPEN, ELM AND MAPLE: REVIEW AND DISCUSSION. Pulp Paper Mag. Can. 71 (16, Aug. 21), (81-4). [34 refs.]
Reviews world literature on the amount and composition of the extractives, and discusses the possible effect of some of them on the discoloration of wood.

Rendos, F. 1964. [STUDY OF NITROGENOUS SUBSTANCES OF WOOD. 1. CHANGES IN THE N CONTENT OF WOOD DURING THE YEAR.] Drev. Vyskum (2), (57-61). 17 refs. [Slovak.slovak. ru.g.e.] P.R.
Tabulates the contents of N during the year in buds, branches, and outer and inner stem wood, of Beech and Spruce (45-50 years old) and Poplar (8-10 years).

Rendos, F., and Domansky, R. 1966. [STUDY OF NITROGENOUS SUBSTANCES OF WOOD. 2. CHARACTER, ISOLATION AND CLASSIFICATION OF THE NITROGENOUS SUBSTANCES OF WOOD.] Drev. Vyskum (2), (67-73). [7 refs. [Slovak.slovak.ru.g.e.] P.R.]
The extraction, paper-electrophoresis, and paper-chromatography techniques used in studying the proteins from peripheral wood of Populus X robusta and Fagus sylvatica are described.

813.9

Rypackova, M., and Tichy, V. 1971. [THE PRESENCE OF FREE RADICALS IN WOOD DECAYED BY FUNGI.] Drevarsky Vyskum 16 (1/2): 123-133 [De.es.ru.e., 31 ref. PR]
Presents and discusses data on the contents of intermediate free radicals of semiquinone structure, determined on the basis of electron spin resonance, in Spruce, Silver Fir and Poplar wood decayed by Ganoderma applanatum, Serpula lacrimans [Merulius lacrymans], Fomes marginatus, Poria cinerascens and Phellinus pilatii.

815 EFFECT OF GROWTH FACTORS ON STRUCTURE AND PROPERTIES

Babos, K. 1969. [FIBRE LENGTH AND DENSITY RELATED TO POSITION IN THE ANNUAL RING IN POPULUS 'ROBUSTA.' Faip. Kutatas. (201-12). [Hu.ru.e.g., 7 refs. P.R.]
A study of wood from 24-year-old stems, on the interrelations of fibre length and density, and of the relation of both to age, position in tree, and position in the annual ring (early, intermediate, and late wood). There was a tendency for density, fibre length and fibre % to increase from early to late wood.

Evrard, R. 1964. [THE QUALITY OF POPLAR WOOD IN RELATION TO ECOLOGICAL FACTORS.] Bull. Soc. For. Belg. 71 (4): 189-222 + 1 photo). 2 refs. [F.f.]
Summarizes research on the effects of site factors on the technological qualities of Poplar (mainly Populus X robusta) grown for match stock. Soil type was of outstanding importance, and type of ground cover was also influential.

Griffioen, K. 1968. [FIBRE DIMENSIONS AND SOME PHYSICAL PROPERTIES OF POPULUS 'ROBUSTA'.] Populier, Wageningen 5 (4): 55-9. [Du.du.]
Wood samples from 3 stems of a 1946 plantation were studied.

Jayme, G., Schenk, U., and Rothamel, L. 1968. [REGULAR CHANGES IN PROPERTIES WITHIN A SINGLE POPLAR STEM.] Transl. Dep. For. Can. No. 228, pp. 21. [11 refs. 8 tbls. Transl. by A. Kuechler and J. L. Keays from Papier, Darmstadt 1949 3 (1/2) (1-7).]

Laing, P. B., Welle, B. J. H. ter, and Griffioen, K. 1972. [SOME ANATOMICAL DATA ON JUVENILE WOOD IN POPLARS.] Populier 9 (1): 13-6. [Nl.e., 23 ref.]
Gives data on fibre length, cell-wall thickness, and lumen diameter in wood samples from a height of 1 m on the NE and SW side of stems of Populus 'Oxford' and P. 'Gelrica'.

Mutibaric, J. 1967. [CHARACTERISTICS OF THE WOOD OF VARIOUS POPLAR SPECIES ON NORMAL CARBONATE ALLUVIAL SOILS.] Topola, Beograd 11 (61/64): 171-81. [Serb. serb.e.e.]
Gives graphs and tables showing the fibre dimensions (length, breadth and lumen diam.), density, shrinkage, fibre saturation point, and number of pores, in samples taken at breast height or at the base of the crown from 2- to 5-year trees of 7 cultivars of Populus X 'canadensis' growing in depressions or on elevated sites.

Mutibaric, J. 1969. [MORPHOLOGICAL CHARACTERISTICS OF WOOD FIBRES AND DENSITY OF JUVENILE WOOD OF HYBRID BLACK POPLARS.] Topola 13 (75/76): 42-7. [Serb.e., 19 refs.]
Tabulates and graphs data on fibre morphology and wood density of 4- and 5-year trees of 8 clones grown in Jugoslavia.

Mutibaric, J. 1971. COMPARATIVE QUALITATIVE RELATIONSHIPS OF WOOD PROPERTIES OF EURAMERICAN POPLARS. DIMENSIONS OF WOOD FIBRES AND SPECIFIC GRAVITY. Silvae Genet. 20 (5/6): 199-204. [11 ref.]
Fibre morphology and density were examined in juvenile wood of 8 cultivars of P. X 'canadensis' planted on alluvial soil in the basin of the R. Danube, near Novi Sad, Yugoslavia.

Nicholls, J. W. P. 1973. WOOD QUALITIES IN POPLAR FROM NORTHERN VICTORIA. Australian Forestry 36 (2): 91-99 [E., 11 ref.]
Describes a study on wood samples from 24-year-old trees of Populus 'Robusta (Grafton hybrids), and the 'Smooth bark' and 'Rough bark' varieties of P. deltoides var. angulata, growing in irrigated plantations in northern Victoria.

Sacre, E. [1964.] [THE RELATIONS BETWEEN THE PHYSICAL AND MECHANICAL PROPERTIES OF POPLAR WOOD AND THE WIDTH OF ANNUAL RINGS.] In Proc. Mtg. Sect. 41 Int. Union For. Res. Organ., Madison 1963 (Working group on wood quality: sub-group on microscopic characteristics) pp. 9 + smries. + 7 gphs. [F.e.g.]

Stojanov, V., and Encev, E. 1965. [PHYSICAL AND MECHANICAL PROPERTIES OF WOOD OF POPULUS X REGENERATA GROWN AWAY FROM WATERCOURSES.] Gorskostop. Nauka, Sofija 2 (1): 75-82. [5 refs. [Bulg.ru.g.].]
Tabulated data from tests on 7 stems from a lowland site and 5 stems from a slope, all aged 20 years and grown away from watercourses, show that wood properties are inferior to those of trees growing, e.g., on an island in the Danube.

Waugh, G. 1972. GROWTH STRESSES – GENETIC AND ENVIRONMENTAL INFLUENCES. Forest Products Newsletter, CSIRO No. 389, 3-4 [E.]
Briefly describes the determination, by non-destructive techniques, of the growth stresses in peripheral woody tissue in standing trees, and discusses the results of a study of such stresses in plantation-grown trees of eight clones of Populus deltoides and its hybrid (with P. nigra) P. X euramericana [P. X canadensis] at four localities in Victoria and New South Wales.

82 CONVERSION, SHAPING, ASSEMBLY AND FINISHING OF WOOD: GENERAL

821 BARKING

Arola, R. A., and Erickson, J. R. 1973. COMPRESSION DEBARKING OF WOOD CHIPS. USDA Forest Service Research Paper, North Central Forest Experiment Station No. NC-85, 11 pp. [E., 6 ref.]
Reports trials of a roller-grinding process on fresh chips of Aspen, Hard Maple, Pinus banksiana, and P. taeda, to determine the influence of several variables on bark removal and wood recovery in one pass through the machine.

Prevost, J. 1965. [BARKING OF SMALL WOOD OF BROADLEAVED SPECIES.] [Publ.] FAO/ECE Jt. Comm. Working Tech. No. LOG/SYMPOSIUM 2/5, pp. 9. [F.]
An account of experiments in barking pulpwood made by the Societe Calaisienne des Pates a Papier, and leading to the development of a special installation.

822 SAWS AND SAWING (DESCRIPTION AND INVESTIGATIONS OF INDIVIDUAL MACHINES AND THEIR FUNCTIONS)

Zividini, R. 1970. ["RU-HO" SYSTEM USED IN SAWING TEST WITH POPLAR AND EUCALYPTUS WOOD.] Indus. Legno. 2 (3): 2802-2808. [It.]

Csizmadia, P. 1969. [PROCESSING OF HUNGARIAN-GROWN POPLARS IN SAWMILLS.] Faip. Kutatas. (75-82). [Hu.ru.e.g., 2 refs. P.R.]
Discusses sawing tests on Populus 'Marilandica,' P. 'Serotina' and P. 'Robusta' with different sawblades. Costs of conversion were higher than for softwood, but this was offset by the lower cost of the timber. Surface quality was no worse.

823 PLANING, CUTTING OF MOULDINGS. CHISELLING, MORTISING AND TENONING. BORING. TURNING

Kel'Nikov, A. V. 1968. [INVESTIGATION OF THE PROCESS OF MILLING DENSIFIED WOOD AT INDUSTRIAL CUTTING SPEEDS.] Nauc. Trud. Leningr. Lesotch. Akad. No. 111, (107-14). 6 refs. [Ru.].]
Studies were made on a thicknesser cutting Birch and Aspen wood in the natural state or compressed by 30% or 50%.

Kahlitzsch, G., and Jostmeier, H. 1964. [KNIFE WEAR WHEN MILLING PARTICLE BOARD.] Holz Roh- u. Werkstoff 22 (4): 139-46. 4 refs. [G.e.] P.R.
A study of cutting forces required and of the state of knives when milling 3-layer Pine boards and boards with a Poplar core and Pine outer layers, at different speeds.

824 FORMS OF JOINT. JOINING AND ASSEMBLY

Kumeghy, G., and Szalay, L. 1973. [POSSIBILITIES OF USING HUNGARIAN WOOD SPECIES IN THE CONSTRUCTIONAL JOINERY INDUSTRY.] In Faipari Kutatasok 1972. pp. 149-169 [Hu.ru.e.de., TRADA]
Shows, with structural diagrams, how Poplar can be used in doors and windows as a substitute for Pine in various components not directly exposed to weather, e.g. as a backing glued to an exterior Pine component. It is concluded that up to 16-21% of Pine could be replaced by Poplar.

824.7

Mutibaric, J. 1966. [THE JOINT STRENGTH OF GLUED WINDOW COMPONENTS FROM CONIFERS AND FAST-GROWN HARDWOODS.] Topola, Beograd 10 (59/60): 51-6. [2 refs. Serb.e.].]
Wood used in the study was from Abies alba (age 90-120 years), Salix Alba (40 years) and several hybrid Black Poplars (14-16 years).

824.8

Troughton, G. E. 1968. RELATIVE EFFECT OF STRESS ON GLUE/WOOD BONDS. Bi-m. Res. Notes Dep. For. Can. 24 (3): 25. [1 ref.]
The factor of stress is dependent on the tree species and is more important in bond failure in Douglas Fir than in Poplar.

Zenkteler, M. 1966. [INVESTIGATIONS ON THE SUITABILITY OF VARIOUS WOOD SPECIES FOR COLD GLUING.] Folia for. polon. (Drzewn.) No. 7, (5-62). [79 refs. [Pol.ru.e.].]
Four softwoods and eleven hardwoods (all native to or naturalized in Europe) and four kinds of cold-setting glue were investigated by comparing glue-line strength with that of solid wood.

826 PEELING, SLICING, TRIMMING AND EDGING OF THIN SHEETS.

Anonymous. 1973. [RESULTS OF SOME PEELING TRIALS [ON POPLARS].] Revue Forestiere Francaise 25 (4): 315-316. [F.]
Tabulates and briefly discusses data from peeling trials on logs of 14 Poplar clones grown in the Dordogne and in northern France.

827 BENDING, MOULDING (OTHER THAN BY CUTTING)

Labsky, O. 1973. THE INFLUENCE OF MOISTURE CONTENT AND PRESSURE UPON SOME CHEMICOPHYSICAL CHANGES IN WOOD WHILE MODIFIED WITH GASEOUS AMMONIA. Drevarsky Vyskum 18 (2): 103-115. [E.sk.ru.de., 28 ref. PR]
Tabulates and discusses data from tests in which Beech, Poplar and Spruce sawdust of 0-50% moisture content was treated with gaseous NH_3 at pressures of 3 and 7 kp/cm^2. All treatment effects were more marked in Beech and Poplar than in Spruce.

83 TIMBER MANUFACTURING INDUSTRIES AND PRODUCTS

Anonymous. 1969. [DISCUSSION ON THE MECHANICAL AND CHEMICAL UTILIZATION OF PLANTATION-GROWN POPLAR AND WILLOW WOOD IN JUGOSLAVIA.] Topola 13 (73/74: 3-57. [Serb.f.]
Gives the text of papers and discussions at a meeting on 25 July 1969 in Jugoslavia, where the annual cut of plantation-grown Poplar and Willow will average 1-1/2 million cu.m. in the period 1970-79, and the requirement in 1985 is estimated at 2,347,000 cu.m. per annum.

Coorens, P. J. H. 1969. [THE USE OF POPLAR WOOD IN THE PACKING INDUSTRY.] Populier 6 (3): 42-43. [Du.]

Hilf, H. H. 1965. [THE UTILIZATION OF SMALL POPLAR WOOD.] Forst- u. Holzw. 20 (1): 3-10. 33 refs. [G.g.] 3 photos. 1 drawing, 4 dgms. 6 gphs. 2 tbls.

Kepsta, D. 1969. [POPLAR WOOD A SUITABLE RAW-MATERIAL FOR BOX PRODUCTION.] Drevo 24 (2): 48-51. [Cz.]

Murphey, W. K., and L. E. Rishel. 1969. RELATIVE STRENGTH OF BOARDS MADE FROM BARK OF SEVERAL SPECIES. Forest Prod. J. 19 (1): 52.
A series of particleboards was made from nine species of eastern tree barks to gain information on the relative strength of bark boards compared to a laboratory produced aspen flakeboard.

Repka, P. 1970. [CREATION OF PRECONDITIONS FOR THE ECONOMIC UTILIZATION OF POPLAR WOOD.] Drevo 25 (9): 244-245. [Cz.]

Venier, G. 1969. [FORECAST OF THE QUANTITATIVE COURSE OF INDUSTRIAL CONSUMPTION OF POPLAR.] Agr. Venezie. 23 (3): 207-215. [It.]

831 FUELWOOD AND VARIOUS TYPES OF ROUGH TIMBER

Chudinov, B. S., and Sokolov, P. V. 1971. CALCULATION OF THE SHRINKAGE OF FUELWOOD DURING STORAGE IN STACKS. In Issledovanie drevesiny i materialov na ee osnove. Krasnoyarsk, USSR, Institut Lesa i Drevesiny, pp. 74-77.

832 MILLS, THEIR FUNCTIONS AND PRODUCTS

Boeykens, G. 1973. [THE USE OF POPLAR WOOD BY THE MATCH INDUSTRY.] Report of the Regional Poplar Congress, Wageningen, the Netherlands. [F.e.]

Hendricks, L. T. 1969. PROCEEDINGS, ASPEN STUD SEMINAR. School of Forestry, Univ. of Minn. St. Paul, Minn. 104 p. illus.

Sekawin, M. 1970. [A LOOK AT THE ITALIAN POPLAR INDUSTRY. SCHWEIZ Z FORSTWESEN.] 121 (11): 824-834. [G.]

832.10

Gehlen. 1965. VERWERTUNG VON PAPPELSTAMMHOLZ IN DER SAGE- UND HOLZVERARBEITUEGS INDUSTRIE. Holzzucht, Reinbek 19 (3/4): S.29, [2 Abb.]

832.18

Kepsta, D. 1970. [QUALITY GRADING OF POPLAR ROUND TIMBER AND THE SAWN TIMBER YIELD.] Drevo 25 (7): 184-187. [Cz.]

832.2

Anonymous. 1966. BIRCH & ASPEN AS BUILDING TIMBERS. Plywood – A Quarterly Journal devoted to the Indian Plywood Industry & Trade Vol. 11, No. 3, pp. 119, Calcutta.

Homenko, E. I., and Septuha, G. F. 1967. [PRODUCTION OF ROTARY VENEER AND PLYWOOD FROM POPLAR.] Derev. Prom. 16 (1): 7-9. [4 refs. [Ru.] P.R.]
A series of experiments was made in the Ukraine on the production of veneer and plywood from Populus alba, P. canescens, P. X 'canadensis', and P. nigra. Details given on the production process and properties of the plywood show that a high-quality product can be obtained.

Jokerst, R. W., and Lutz, J. F. 1974. OAK-COTTONWOOD PLYWOOD – MINIMUM CURE TIME. U.S., Forest Products Laboratory U.S.D.A. For. Serv. Res. Pap. FPL – 231, 4 p.

Konno, H., Suzuki, T., Kudo, O., and Kurata, H. 1972. [YIELD OF CORE-STRIPE FOR LUMBERCORE-PLYWOOD FROM POPLAR.] Hokkaido Forest Prod. Res. Inst. J. 9: 12-14. [Jap.e.]

Samek, J. 1967. QUALITY YIELD IN THE PRODUCTION OF ROTARY-CUT VENEERS. Transl. Commonw. Sci. Industr. Res. Organ. Aust. No. 9214, 1968. pp. 7. [8 refs. Transl. by E. Pichler from Drevo (9), (319-21). [Cz.] Limited distribution.]
Results of a visual classification of Beech, Poplar, Pine and Fir [Spruce?] veneers into 5 grades based on defects that affect the mechanical properties of the plywood show that Poplar produced the smallest and Beech the largest proportion of high-grade veneers.

Steller, S. 1965. [COEFFICIENT OF COMPRESSION OF PLYWOOD.] Drevo 20 (7): 246-8. 8 refs. [Slovak.ru.e.g.] P.R.
Mean compression coefficients were calculated, and found to range from 1·42% for Poplar at 10 kg./sq.cm. to 9·99% for Scots Pine at 18 kg./sq.cm. In all cases, compression was well below the prescribed values.

Steller, S. 1967. [STRENGTH PROPERTIES OF WATERPROOF PLYWOODS OF VARIOUS WOOD SPECIES, AND THEIR QUALITY INDICES.] Drev. Vyskum (4), (203-14). [8 refs. [Slovak.slovak.ru.g.e.] P.R.]
Gives mean test values obtained for the strength properties of 3-, 5- and 7-ply sheets of Beech, Scots Pine, Norway Spruce and Poplar. These values are then used to calculate quality indices as described previously.

832.281

Quiquandon, B. 1973. [THE USE OF POPLAR FOR SAWING AND ROTARY VENEER CUTTING.] Report of the Regional Poplar Congress, Wageningen, the Netherlands. [F.e.]

832.282

Haber, J. 1965. DIE BEDEUTUNG DES PAPPELHOLZES FUR DIE SPERRHOLZ- UND SPANPLATTENINDUSTRIE. Holzzucht, Reinbek 19 (3/4): 27-28.

Takaya, N., Ogura, T., Nozaki, K., and Taguti, T. 1972. [THE PRODUCTION OF POPLAR PLYWOOD.] Hokkaido Forest Prod. Res. Inst. J. 2: 1-5. [Jap.e.]

832.3

Anonymous. 1965. [INVESTIGATION INTO THE PROCESSIN OF 3 VARIETIES OF CULTIVATED POPLARS IN A MATC FACTORY AND A CLOG FACTORY.] Report H 65-23 Houti stituut TNO (Forest Products Research Institute TNO), Delft. [Du.]

Adema, K. 1965. PAPPELHOLZ FUR DIE ZUNDHOLZIN DUSTRIE. Holzzucht, Reinbek 19 (3/4): S.30.

Boeykens, G. 1974. [THE USE OF POPLAR WOOD BY TH MATCH INDUSTRY.] Populier 11 (2): 24-28. [Nl.]
Describes the wood-quality requirements for match manufactur the yield in peeling, prices of Poplar peeler logs in Belgium, and th prospects for and factors affecting the use of Poplar wood in th match industry in the EEC.

Govers, A., and Griffioen, K. 1965. [A STUDY OF RECOVER FROM VARIOUS POPLAR CULTIVARS IN THE MATCH AN WOODEN-SHOE INDUSTRIES.] Populier, Wageningen 2 (4): 9-1 [Du.]
In studies at match factories in 1961 and 1964 there was very litt difference in total recovery ((a) matchstick veneers + (b) bo veneers) between cys. 'Marilandica', 'Robusta', 'Scrotina' 'Heidemij', 'Keppels Glorie', 'Gelrica' and 'Regenerata', but propo tions of (a) and (b) varied widely.

Jansen, E. C. 1974. [INVESTIGATIONS ON THE SUITABILIT OF WOOD OF POPULUS 'DORSKAMP', 'FLEVO' AND '924' FO THE MANUFACTURE OF MATCHES.] Internal Report nr. 6 Forest Research Station, Wageningen. [Du.]

832.5

Jobling, J. 1965. POPLARS: VARIETAL STUDIES. Extr. fro Rep. For. Res. For. Comm. Lond. 1963/64, (40-2).
A preliminary examination of the timber of certain Balsam Popla was undertaken to ascertain their potential usefulness for the matc industry. The clones tested were Populus 'Androscoggin', P. 'O.P. 42', P. trichocarpa CF, P. tacamahaca X P. trichocarpa CF, and P nigra X P. trichocarpa.

834 SHINGLES. COOPERAGE. PACKING CONTAINERS (MANUFACTURE AND USE)

Veldhuyzen, C. J. 1973. [DEVELOPMENT IN THE USE O POPLAR WOOD BY THE PACKAGING INDUSTRY BETWEE 1966 AND 1971.] Populier 10 (1): 3-4. [Du.]

836 FURNITURE AND CABINET-MAKING

Dezso, L., and Gyula, R. 1970. [THE POSSIBLE SUBSTITUTIO OF PINE TIMBER WITH POPLAR IN THE FURNITURE INDUS TRY.] Faipar 20 (4): 108-109. [Hu.]

836.1

Mutibaric, Jovan. 1968. [SUBSTITUTION OF CONIFER WOO BY POPLAR AND WILLOW WOOD IN THE PRODUCTION O FURNITURE.] Novi Sad 223 p. illus. [Croat.]

839 MISCELLANEOUS

839.8

Milleit, M. A., Baker, A. J., et al. 1970. MODIFYING WOOD TO INCREASE ITS IN VITRO DIGESTIBILITY. Repr. from Journa of Animal Science [Fort Collins] 31 (4): 781-8. [31 refs. PR.]
Among 24 tree species studied for the potential use of their woo residues as fodder for cattle, the highest in vitro digestibilities wer shown by Aspen (Populus spp.), Fraxinus nigra and Soft Mapl [Acer rubrum?] – 32, 71 and 20% respectively.

Veresova, I. M., et al. 1968. [USE OF SAWDUST COMPOSTS A FERTILIZERS FOR AGRICULTURAL AND FOREST CROPS.] Nauc. Trud. Leningr. Lesotch. Aka. No. 110, (160-4). [16 refs [Ru.].]
Tabulates data showing the improvements in yield and quality o lettuce, potatoes and conifer seedlings brought about by the use o composts including Aspen sawdust, bark, and rotten wood.

84 PRESERVATION AND OTHER TREATMENTS TO IMPROVE THE PROPERTIES OF WOOD. DAMAGING INFLUENCES

ziraky, J. 1974. A NEW METHOD FOR TECHNICAL DRYING F POPLAR. Faipar 24 (10): 292-294. [Hu.]

841 WOOD PRESERVATION

arr, N. 1970. WOOD PRESERVATION. Repr. from New Zealand armer 91 (3): 49.
ery briefly describes preliminary tests of the penetration of K.33, Cu-Cr-As preparation applied to barked posts and poles by sap isplacement.

hiani, R. G. 1964. [STATE OF THE IMPREGNATED-FENCE-OST TRIAL PLOTS SET UP IN THE '25 de MAYO' FOREST URSERY 4 AND 5 YEARS AFTER THEIR INSTALLATION.] otas tecnol. for. Adm. Nac. Bosques, B. Aires No. 24, pp. 13. 4 efs. [Span.span.]
ives the results of tests of impregnated fence posts in service for -5 years. The Eucalypts proved more resistant than Casuarina unninghamiana, while, judging from these tests, Populus X 'anadensis' and Salix alba var. calva give less than 4 years' useful ervice.

hiana, R. G. 1967. [THE DURABILITY OF TREATED AND NTREATED FENCE POSTS IN PLOTS IN THE CITY OF UENOS AIRES.] Foll. tec. Adm. Nac. Bosques, B. Aires No. 31, p. 30. [15 refs. [Span.].]
even treatments were tested on 18 species suitable for fence posts. reliminary data indicate that the diffusion process, and the ot-and-cold method using oil-borne preservatives, are cheapest and ost effective. Among untreated controls Populus X 'canadensis' as so far proved less durable than Eucalyptus spp.

achelarescu, F., Boiciuc, M., and Vintila, E. 1964. [THE PRO-ECTION OF WOOD USED IN MAKING GREENHOUSE FLATS ND COLD FRAMES FOR GROWING VEGETABLES.] Industr. emn. 15 (12): 460-4. 21 refs. [Ro.ru.g.f.e.]
escribes experiments which indicated that a number of hardwoods Alder, Hornbeam, Beech, Ash, Poplar, Oak, Elm) can be safely used r this purpose if given fungicidal treatment (3% PCP is recom-ended) and finished with an enamel paint.

into, J. C. 1964. [FIRST RESULTS ON THE DURABILITY OF MPREGNATED POSTS AND STAKES.] Bol. argent. for. 2 (235): 9-11. [Span.span.]
ucalypts were more durable than Poplar. The most successful reservatives were $CuSo_4$, Basilit, and $ZnCl_2$ mixed with alkali icarbonates.

842 TREATMENTS TO IMPROVE THE RESISTANCE OF WOOD TO PHYSICAL AND CHEMICAL AGENCIES

wniczak, M. 1972. [EFFECT OF MODIFYING POPLAR WOOD ITH ISOCYANATES ON SOME OF ITS PROPERTIES.] Folia orestalia Polonica, B. No. 11 (67-82). [Pl.ru.e. 6 ref.]

eall, F. C., Meyer, J. A., and Skaar, C. 1966. DIRECT AND RF EAT CURING OF WOOD-PLASTIC COMPOSITES. For. Prod. J. 6 (9): 99-106. [11 refs.]
ven-dry sapwood of Aspen (Populus sp.) and Basswood (Tilia sp.). npregnated with methyl methacrylate (using various organic eroxides to initiate polymerization), was subjected to direct eating in a bath at 68° C. and R.F. heating to 90-98°; this resulted 1 66 and 51% polymer volume retention respectively.

illwald, W., and Lehmann, G. 1967. [IMPROVEMENT OF WOOD OR PARTICULAR USES BY IMPREGNATION WITH UREA-ORMALDEHYDE RESINS.] Holztechnol., Dresden 8 (4): 275-8. 3 refs. [G.g.ru.e.] P.R.]
imilar impregnation treatments of soft hardwoods used in pattern aking (including Poplar, Birch and, in particular, Alder) produced imilar positive effects on sorption and swelling, resistance to brasion and fire, and strength properties.

esek, M., Jarkovsky, J., and Pultar, F. 1969. [RADIATION OLYMERIZATION OF METHYL METHARCRYLATE IN VOOD. EFFECT OF ORGANIC HALOGEN COMPOUNDS ON HE RATE OF POLYMERIZATION.] Chemicky Prumysl. Praha 9 (11): 503-6. [Cz., 11 refs. From abstr. in J. appl. Chem. 1970 20 (3), (i 168). O.R.S.]
In a study of Spruce, Pine, Poplar and Beech, polymerization rates were increased in the presence of halogen-containing organic compounds and also increased with increasing m.c.

Varga, S., et al. 1967. [RADIATION POLYMERIZATION OF STYRENE AND ACRYLONITRILE IN POPLAR WOOD.] Drev. Vyskum (3), (143-50). [15 refs. [Slovak.slovak.ru.g.e.] P.R.]
Describes studies on the physical and mechanical properties of Populus X marilandica wood impregnated with styrene or acrylonitrile and then exposed to CO^{60} radiation (at doses of 0·5-15 Mrad) to induce polymerization.

844 ATTACK BY PLANT ORGANISMS

Manka, K., Gierczak, M., and Kowalski, S. 1972. [PENETRATION INTO SOAP OF FUNGI FROM WOOD PACKING.] Prace Komisji Nauk Rolniczych i Komisji Nauk Lesnych 34: 121-125. [Pl.e., 3 ref. NLL]
Lists 33 species of fungi isolated from soap and/or the Poplar slats in which the soap was packed. The fungi found most frequently in both substrates were Penicillium spp., Rhozopus nigricans and Mucor spinescens.

Plavsic, V. 1967. [THE BIOLOGY OF FUNGI CAUSING DISCOLORATION ON WOOD OF POPLARS OR WILLOWS.] Topola, Beograd 11 (61/64): 156-60. [18 refs. [Serb.serb.e.] 3 tbls.]
The fungi causing discoloration in 20% of the logs in pulpwood, veneer and sawlog yards are Fungi imperfecti and Ascomycetes. Their metabolic products include amylolytic and oxidation enzymes and cellulose.

844.1

Pinheiro, A. C. 1971. [BLUESTAIN IN POPLAR WOOD.] [Publicacao,] Instituto de Investigacao Agronomica de Angola (IIAA) (Serie Cientifica). Nova Lisboa No. 21, pp. vi + 39 + 8 plates. [Pt.e.f. 42 ref.]
Presents the results of studies of wood in Portugal, giving information on the fungi isolated, the reduction of static and impact bending strength in affected wood, and chemical treatments for the control of bluestain.

Pinheiro, A. C. A. 1971. BLUE-STAIN IN POPLAR WOOD. Material und Organismen 6 (2): 93-100. [E.de.f.es., 1 ref. PR]
The three species of fungi mainly responsible for bluestain in Poplar in Portugal were found to be Hendersonula sp., Botryosphaeria obtusa and Botryodiplodia theobromae.

844.2

Anonymous. 1966. CHEMICAL MODIFICATION OF WOOD BY ORGANISMS. Mater. u. Organ., Berl.: Suppl. No. 1 (Holz und Organismen), (88-196). [181 refs. [E.F. or G.e.f.g.].]

Costa, E. W. B. da, and Kerruish, R. M. 1964. TOLERANCE OF PORIA SPECIES TO COPPER-BASED WOOD PRESERVATIVES. For. Prod. J. 14 (3): 106-12. 18 refs.
Of 35 species (57 isolates), no white-rot but most brown-rot species were highly resistant to Cu chromate and $CuSO_4$ and four, including P. vaillantii and P. incrassata, also to Cu-Cr arsenate.

Curikova, E. K. 1967. [COMPARATIVE RESISTANCE OF THE WOOD OF POPLARS TO CONIOPHORA CEREBELLA.] Lesn. Z., Arhangel'sk 10 (3): 120-2 + 6 gphs.) [14 refs. [Ru.].]
Graphs wood weight losses up to 90 days in soil/wood tests on specimens of Populus nigra, P. X marilandica, P. alba, P. canescens, and P. tremula (dark-barked and green-barked forms).

Eslyn, W. E. 1966. RELATION OF VISUAL ESTIMATES OF DECAY TO SPECIFIC GRAVITY LOSS IN STORED COTTONWOOD AND WILLOW [PULPWOOD]. U.S. For. Serv. Res. Note U.S. For. Prod. Lab., Madison No. FPL-0143, pp. 4 + 1 gph. [3 refs.]
Visual estimates of decay and actual losses in sp.gr. in bolts of Populus sp. and Salix sp. were plotted and compared by host species and type of decay.

King, N. J., and Fuller, D. B. 1968. THE XYLANASE SYSTEM OF CONIOPHORA CEREBELLA. Biochem. J. 108 (4): 571-6. [20 refs. O.R.S.]
The culture filtrate of C. cerebella grown on Poplar 4-O-methylglu-

curonoxylan contained an enzyme system that degraded the polysaccharide to xylose, acidic and neutral oligosaccharides and an enzyme-resistant polymer.

Kubiak, M. 1964. [CHANGES IN CERTAIN CHEMICAL AND MECHANICAL PROPERTIES OF PINE, POPLAR, AND BEECH WOOD UNDER THE INFLUENCE OF FUNGAL ACTION.] Sylwan 108 (1): 43-6. 5 refs. [Pol.ru.e.]
Changes were of an interdependent character and may be expressed by a first-degree regression equation. The proportion of lignin in attacked wood was not decisive for compression strength ⊥, from which it follows that lignin fulfils its strength role in sound wood only in combination with the cellulose.

Kubiak, M. 1964. [THE EFFECT OF VARIOUS FUNGI ON THE TECHNICAL PROPERTIES OF POPULUS X MARILANDICA.] Drev. Vyskum (4), (171-85). 24 refs. [Slovak.ru.g.e.] P.R.
Wood of P. X marilandica was exposed to 12 different species of fungi for 10, 30, 60 and 90 days.

Levy, J. F. 1967. DECAY AND DEGRADE OF WOOD BY SOFT ROT FUNGI AND OTHER ORGANISMS. Int. Pest Control, Lond. 9 (6): 28-34. [52 refs.]
Reviews recent work at the Imperial College of Science and Technology, London, and elsewhere, and attempts some interpretations of the phenomena observed.

Rajagopalan, C. 1965. COMPARATIVE STUDIES ON FOUR SPECIES OF WOOD-ROTTING FUNGI. Transactions of the Kansas Academy of Science, Lawrence 68 (4): 541-52. [18 refs. C.G.B.]
Nutritional and temperature requirements, enzyme activities and decaying abilities of two ascomycetes, Xylaria digitata and Hypoxylon rubiginosum, and two basidiomycetes, Polyporus cinnabarinus and P. conchifer were compared.

Stranks, D.W. 1970. TRICHODERMA VIRIDE ENZYMIC DEGRADATION OF WOOD STRUCTURE. Bi-m. Res. Notes 26 (3): 23-4. [2 refs.]

Vehovszky, J. 1968. [THE DURABILITY OF POPLAR WOOD.] Faip. Kutatas., Budapest (1), (87-99). [16 refs. [Hu.hu.ru.e.g.] P.R.]
In exposure tests with 3 white-rot and 3 brown-rot fungi, the wood of both Populus 'Robusta' and P. 'Serotina' was of poor natural durability.

845 ATTACK BY ANIMALS

Danilewicz, K., and Tomaszewski, M. 1972. [DEGRADATION OF LIGNIN BY PSEUDOMONAS MIGULA ISOLATED FROM INTESTINAL CONTENTS OF PARANTHRENE TABANIFORMIS ROTT.] Acta Microbiol. Polon. Ser. B. Microbiol. Appl. 4 (1): 37-46.

845.3

Hrdy, I. 1970. LABORATORY COLONIES OF MICROCERETERMES CAMERONI SNYDER (ISOPTERA). J. Indian Acad. Wood Sci. 1 (1): 11-8. [13 refs.]
In feeding experiments at Bangalore and Prague, M. cameroni distinctly preferred the wood of Vateria indica and Populus sp. to that of Pinus sylvestris, which remained almost undamaged. The termites survived up to 2 to 3 months and longer.

Seifert, K., and Becker, G. 1965. [CHEMICAL DECOMPOSITION OF HARDWOODS AND SOFTWOODS BY VARIOUS TERMITES.] Holzforschung, Berlin 19 (4): 105-11. 12 refs. [G.g.e.] P.R.

846 STEAMING

Ilic, M. 1970. [TEMPERATURE CHANGE AND ITS EFFECT ON THE QUALITY OF POPLAR AND OKOUME LOGS FOR VENEER PRODUCTION.] Pregled naucnoteh. Rad. Inform., Zavod Tehn. Drveta 7 (1/2): 1-14. [Serb.g., 14 refs. P.R.]
The optimum schedule for Poplar and Okoume logs up to 55 cm. diam. is steaming for 8-10 hr., and cooling for 6-8 hr. (75% of the cooling being in an enclosed chamber).

847 DRYING (SEASONING)

Fabian, T. 1969. [KILN DRYING OF SAWN TIMBER OF POPULUS 'ROBUSTA'.] Faip. Kutatas. (89-99). [Hu.ru.e.g., 6 refs. P.R.]
Discusses trials suggesting that published drying schedules are not applicable in practice. Super-heated steam can be used only below fibre saturation point, but even then, drying at 100° C. results in a discoloration. The cost of conventional drying is less than for softwood when the initial moisture content is near fibre saturation point.

Wittmann, G. 1971. [ACCELERATED AIR SEASONING OF POPLAR AND ROBINA SAWN TIMBER.] Faip. Kutatas. 1970 (83-93). [Hu.ru.e.de., 7 ref. PR]
Describes Hungarian trials with fan-assisted accelerated air drying, discussing drying rates and costs at different times of the year and concluding that the method is economic for reducing moisture content to fibre saturation point even during part of the winter.

Wittmann, G. 1969. [AIR DRYING OF SAWN TIMBER OF POPULUS 'ROBUSTA'.] Faip. Kutatas. (83-8). [Hu.ru.e.g., 3 refs. P.R.]
Discusses drying rates and times in relation to mean monthly temperatures, moisture content, and board thickness. Poplar took nearly twice as long to dry as Spruce and over one-third longer than Scots Pine.

848 TIMBERYARD PRACTICE. HANDLING AND STORAGE OF TIMBER.

Gambetta, A., and Orlandi, E. 1971. [DETERIORATION OF POPLAR WOOD STORED AS CHIPS.] Contributi Scientifico-Practici per una Migliore Conoscenza ed Utilizzazione del Legno 15 (34): 29-40. [It.f.e. 29 ref.]
A study of Poplar chips stored in the open in Lombardy showed that soft-rot fungi were the primary cause of deterioration.

Gambetta, A., and Orlandi, E. 1973. MICROBIOLOGICAL ALTERATION OF POPLAR WOOD STORED IN THE FORM OF CHIPS. Translation, Environment Canada No. Ooenv Tr 194. 14 pp. [E., Transl. from Contributi Scientifico-Practici per una Migliore Conoscenze ed Utilizzazione del Legno (1971) 15 (34): 31-40. See FA 34, 2524. Limited distribution.]

Giordano, G. 1969. [CHANGES IN WOOD DURING STORAGE.] Cellulosa e Carta 20 (10): 23-6. [It.f.e.g.]
Draws the attention of pulp and paper technologists to the changes, detrimental to the homogeneity of their raw material, that occur in woody tissue both within the standing tree (with age) and in stored logs after felling (with time and attack by fungi), and discusses particularly problems connected with heart-wood formation in Poplar and Eucalyptus camaldulensis, for which chemical methods of distinguishing sapwood and heartwood are described and illustrated.

Jacquiot, C., and Lapetite, D. 1967. [THE ROLE OF BACTERIA IN THE PRESERVATION OF PILED PULPWOOD CHIPS.] C. R. Acad. Agric. France 53 (12): 899-902. [[F.] A.P.B.]
Beech, Oak, Alder, Birch and Poplar chips were examined for micro-organisms after 1, 2, 3, 6, 9, 12 and 15 months' storage in the open. Few wood-rotting fungi were found, and those were on fresh wood, or wood stored for 9 months or more. Colonies of bacteria were numerous.

85 "GRADING" OF WOOD AND WOOD PRODUCTS

Sacre, E. 1973. [STUDY OF THE WOOD OF POPULUS 'I-214', P. 'ROBUSTA' AND P. 'GELRICA'. PART 1.] Bulletin de la Societe Royale Forestiere de Belgique 80 (3): 141-159. [F.nl.]

851 TIMBER QUALITY IN GENERAL

Govers, A. 1973. [A STUDY ON THE POSSIBILITIES OF A FAST ESTIMATION OF THE QUALITY OF POPLAR WOOD.] Houtinstituut TNO (Forest Products Research Institute TNO). [E.]

852 DETECTION, RECOGNITION & ASSESSMENT OF INJURIES AND DEFECTS

Sacre, E., and Evrard, R. 1964. [THE INFLUENCE OF TENSION WOOD IN POPLARS ON THE YIELD OF ROTARY VENEER AND ON PHYSICAL AND MECHANICAL PROPERTIES.] In Proc. Mtg. Sect. 41 Int. Union For. Res. Organ., Madison 1963 (Working group on wood quality: sub-group on microscopic

:haracteristics) pp. 19 + smries. [F.e.g.]
Presents data on yields from veneer logs, and of sound and 'woolly' veneer for 12 hybrid Black Poplars resembling Populus X serotina, and 12 of the 'regenere' type.

Zenker, R., and Muller-Stoll, W. R. 1966. [THE INFLUENCE OF TENSION WOOD ON STRENGTH PROPERTIES OF POPLAR IN DRY OR WET CONDITION.] Holztechnol., Dresden 7 (1): 17-25. 16 refs. [G.g.ru.e.] P.R.
In a study of wood from five Populus X robusta and one P. X regenerata, increasing tension wood % caused increases in strength in tension at 12% m.c. and reductions in compression strength and bending strength in the wet state, but affected wet strength in tension and dry strength in bending and compression little or not at all.

86 PULP INDUSTRIES

861 PULP AND PAPER MANUFACTURE. TEXTILE AND OTHER CELLULOSE DERIVATIVES

Akim, L. E., and Brjuzgina, T. S. 1969. [EFFECT OF PRELIMINARY HYDROLYSIS ON THE QUALITATIVE INDICES OF UNBLEACHED SULPHATE PULP FROM POPLAR WOOD.] Lesn. Z. 12 (6): 106-10. [Ru., 5 refs.]
Laboratory studies on the effect of water prehydrolysis showed that a sulphate pulp having a high α-cellulose content, high viscosity, and low pentosan content could be obtained.

Anton, I., Apiula, N. 1972. [EXPERIMENTS TO OBTAIN BISULPHITE PULP FOR THE MANUFACTURE OF FINE PARCHMENT FROM POPLAR WOOD.] Celuloza si Hirtie 21 (1): 26-37. [Ro.] From Cellulosa e Carta 24 (1): 58. [it.]
Gives results of a study of the optimum pulping procedure for producing fine parchment and other types of grease-proof paper from Poplar wood.

Augustin, H. 1973. [USE OF POPLAR IN THE CELLULOSE AND PAPER INDUSTRY.] Holzzucht 27 (3): 21-24. [G.]

Augustin, H. 1973. [UTILIZATION OF POPLAR BY THE PULP AND PAPER INDUSTRY.] Report of the Regional Poplar Congress, Wageningen, the Netherlands. [G.]

Azzola, F. K., Ginzel, W., and Saad, S. M. 1970. [LIGHT AND TRANSMISSION ELECTRON MICROSCOPE STUDIES ON SEMI-CHEMICAL PULPS PREPARED FROM POPULUS X MARILANDICA IN ALKALINE AND ALKALINE-OXIDIZING MEDIUM AND ON GROUNDWOOD PULP.] Holzforschung 24 (4): 105-12. [De.e., 7 ref. PR]

Branch, B. A. 1971. THE EFFECT OF WOOD SPECIES AND BARKING ON CORRUGATING MEDIUM QUALITY. Pulp Paper Mag. Can. (8), (84-7). [3 ref.]
Mill trials were made at Bathurst, New Brunswick, with the object of raising the Corrugating Medium Test (CMT) value – a measure of quality – of the corrugating medium produced to meet the requirements of the European market specifications for this material.

Bryuzgina, T. S., and Akim, L. E. 1969. [INFLUENCE OF THE CONDITIONS OF SULPHATE COOKING (WITH PRE-HYDROLYSIS) OF POPLAR WOOD ON THE QUALITY CHARACTERISTICS OF UNBLEACHED PULP.] J. Appl. Chem. USSR 42 (12): 2651-2654.

Burkart, L. F. 1964. THE COOKING PROCESS XIV. THE ACTION OF AQUEOUS SOLUTIONS OF PURE SODIUM HYDROSULFIDE ON ASPEN WOOD [SAWDUST]. Abstr. of thesis, in Dissert. Abstr. 25 (5): 2688-9. O.R.S.

Casperson, G., Philipp, B., et al. 1969. SWELLING BEHAVIOUR OF NORMAL AND 'TENSION' WOOD FIBRES OF POPLAR. Faserforschung und Textiltechnik, Berlin 20, (61-70). [G. 35 refs. From abstr. in J. appl. Chem. 19 (8): ii 157. O.R.S.]
The swelling of normal and tension-wood fibres in sulphate pulp of Populus X robusta after pulping, bleaching and air drying was studied by optical and electron microscopy, using various swelling agents. Tension-wood fibres presented considerable resistance to swelling.

Ceragioli, G., and Ventura, B. 1970. [SEMI-CHEMICAL PULPS FROM POPLAR WOOD BY A NO-PRESSURE HOT-CAUSTIC (NPHC) PULPING PROCESS FOR PACKING AND IMPREGNATION PAPERS.] Indus Carta 8 (12): 461-470. [It.]

Enderst, V. and Jancl, J. 1974/1975. [THE PRESENT POSITION AND PROSPECT OF CHEMICAL PROCESSING OF POPLAR WOOD IN CZECHOSLOVAKIA.] Topola 18/19 (103/106): 51-56. [Sh.e.ru.]
Summarizes experience, with data on the neutral sulphite pulping of Populus canescens, P. 'marilandica', P. nigra and P. 'Robusta', and trials with different pulping processes.

Fahmy, Y., and El-Saied, H. 1974. CHEMICAL MODIFICATION OF [POPLAR] PULP AND PHYSICALLY ADDED CHEMICALS IN PAPER MAKING. I. FIBER MODIFICATION BY CLASSICAL CELLULOSE HYDROPHILIZING AND HYDROPHOBIZING REACTIONS IN COMPARISON TO PHYSICALLY ADDED CELLULOSE DERIVATIVES. II. GRAFTING COPOLYMERISATION WITH HYDROPHILIC AND HYDROPHOBIC MONOMERS AND THEIR BINARY MIXTURES IN COMPARISON TO PHYSICALLY ADDED HOMO-POLYMERS AND TO CLASSICAL CHEMICAL MODIFICATION. Holzforschung 28 (1;2): 29-34; 61-66. [E.de., 26 ref.]

Feiner, J. H., and Gallay, W. A. 1965. A MODIFIED SINGLE-STAGE SODIUM-BASE BISULPHITE PROCESS. Pulp Paper Mag. Can. 66 (2): 777-783. 6 refs.
Tested on Spruce, Balsam Fir, Pine, Poplar, and several dense hardwoods, this method produces a very uniform product from different wood lots from various sources, besides having other advantages.

Fisher-Zach, H. 1965. VERWENDUNG VON PAPPELHOLZ IN DER ZELLSTOFF- UND PAPIERINDUSTRIE. Holzzucht, Reinbek 19 (3/4): 25-27.

Gartner, W. 1964. VERBESSERUNG DES MAHLUND SCHLEIFPROZESSEES BEI ZELLSTOFF UND PAPPELHOLZ DURCH MITVERWENDUNG VON CHEMIKALIEN. Wbl. Papierfabrikation, Biberach/RiB 92, 728-733. Ref. in. Chem. Zentralbl., Berlin u. Weinh. 137 (1966), 5, S. 1703.

Gasparic, Z., and Stankovic, M. 1974/1975. [UTILIZATION OF SOFT HARDWOODS FROM NATURAL STANDS AND PLANTATIONS FOR THE PRODUCTION OF SULPHATE PULP.] Topola 18/19 (103/106): 165-169. [Sh.e.ru.]
Reports pulping trials in Yugoslavia on 5 hybrid Black Poplar clones and native Populus nigra, P. alba and Salix spp.

Ginzel, W., Saad, S. M., and Stegmann, G. 1969. [PRODUCTION OF SEMICHEMICAL PULP FROM HARDWOOD IN AN ALKALINE OXIDIZING MEDIUM CONTAINING WATERGLASS.] Holzforschung, Berlin 23 (5): 152-63. [G.e., 20 refs. P.R.]
An investigation of the pulping of Populus X marilandica and Carpinus betulus by means of NaOH in presence of H_2O_2, and of the stabilizing effect of waterglass.

Giordano, G., and Bosso, G. 1968. [[I] WHAT IS THE FUTURE OF THE INDUSTRIAL USES OF POPLAR? [II] PROSPECTS FOR THE CONSUMPTION OF POPLAR FOR PAPERMAKING WITHIN THE EUROPEAN COMMON MARKET.] Cellulosa e Carta 19 (5): 5-20. [It.f.e.g.]

Gorbaceva, G. N., and Ivanov, S. N. 1968. [THE EFFECTS OF THE MORPHOLOGY AND FIBRE DIMENSIONS OF PULP FROM HARDWOODS ON PAPER PROPERTIES.] Bumaz. Prom., Moskva (5), (5-7). [3 ref. [Ru.ru.e.] N.L.L.]
Includes results of a study on: the length, thickness, length/thickness ratio, cell-wall thickness, number per mg., etc. of libriform fibres and tracheids, vessels and parenchyma cells and their length distribution by weight in sulphate pulps of Poplar, Aspen, Birch and Spruce; and the beating times for the different pulps, and their pentosan content, viscosity and breaking length.

Huang, M. Z. 1971. [INVESTIGATIONS ON FIBRE MORPHOLOGY AND NSSC PULPING EXPERIMENT WITH POPULUS 'I-214', '70D' AND '64H',] Istanbul Universitesi Orman Fakultesi Dergisi, A 21 (1): 159-181. [Tr.e., 54 ref.]

Istas, J. R., and Raekelboom, E. L. 1970. [THE BIOMETRY, CHEMISTRY AND PAPER-MAKING QUALITIES OF SOME BROADLEAVED SPECIES GROWN IN THE ARBORETUM [AT TERVUREN].] Publication, Arboretum Geographique, Tervuren No. 5, pp. 137. [F.du.e., P.R.]
Details are given of wood chemistry, density, fibre characteristics, sulphate pulping, and pulp and paper characteristics.

Ivannikov, S. P., and Rostovcev, S. A. 1965. [CELLULOSE CONTENT AND FIBRE DIMENSIONS IN VARIOUS POPLAR VARIETIES.] Lesn. Hoz. 18 (5): 37-42. [Ru.]
Tabulates data for some 50 species and hybrids, showing that the wood properties of those that are the most promising as raw material for pulp and paper will vary from one area to another.

Jayme, G., and Krause, T. 1965. [THE STATISTICAL EVALUATION OF THE RELATIONSHIP BETWEEN CHEMICAL COMPOSITION AND STRENGTH PROPERTIES OF POPLAR SULPHITE PULPS.] Papier, Darmstadt 19 (7): 330-6. 22 refs. [G.g.e.f.] P.O.
The relationships of pulp strength to chemical composition and certain wood properties were studied. Tension wood caused a marked decrease in all strength properties. Increasing fibre length gave increasing pulp strength.

Kalish, J. 1973. VIKING – THE TURKISH/DANISH JOINT VENTURE COMPLETES FIRST FULL YEAR OF OPERATION. Pulp and Paper International 15 (5): 70-73. [E.f.de.es.]
Reports the successful establishment, by Viking Pulp and Paper Ltd., of a small pulp and paper mill on the Turkish coast N. of Izmir.

Kazantsev, I. Y., Maslov, V. A., and Kantemirova, L. A. 1973. [POSSIBILITIES OF GROWING HYBRID POPLARS AND OF USING THEM IN THE PULP AND PAPER INDUSTRY ON THE LOWER VOLGA.] Lesnoi Zhurnal 16 (2): 166-169. [Ru., 12 ref.]
Gives results of trials with several species and clones of Poplar in the Astrakhan region, and presents data on wood anatomy, chemistry, and sulphate pulp properties for the six most promising Poplars, viz. Populus balsamifera X P. canescens No. 4 B, P. alba var. pyramidalis, local P. nigra, 'Russian Poplar' (P. nigra var. italica X P. nigra), P. 'Robusta' No. 236, and P. 'Brabantica' No. 175.

Kirpicheva, L. M., Akim, L. E., and Ferina, T. F. 1971. [THE EFFECT OF INDEPENDENT VARIABLES OF SULFATE COOKING ON QUALITATIVE INDICES AND CARBOHYDRATE COMPOSITION OF UNBLEACHED PULP FROM POPULUS WOOD.] Les. Zh. 4: 97-99. [Ru.]

Kleinert, T. N., and Marraccini, L. M. 1965. VAPOR-PHASE KRAFT COOKING OF VARIOUS WOOD SPECIES. Tappi 48 (5): 270-2. 10 refs.
Describes an investigation of vapour-phase cooking of commercial chips impregnated with kraft liquor, using mixtures of W. Canadian softwoods, Pinus pinaster, and mixtures of E. Canadian hardwoods, especially those of high density, including Elm, Maple, Beech, Birch and Poplar.

Kny, A. 1964. [POPLAR GROUNDWOOD PULP FOR MAKING NEWSPRINT AND MEDIUM-FINE PAPERS.] Holzzucht, Reinbek 18 (1/2): 8-10. [G.]
Discusses grinding processes (including pressure wetting), paper properties etc. One Austrian mill adds 14% Poplar wood (Black Poplar, hybrid Black Poplar or Aspen, but not White Poplar or Willow) to Spruce for newsprint and up to 50% for medium-fine papers.

Lee, M. C., Jo, B. M., Lim, K P., and Chun, P. C. 1974. [STUDIES ON THE MECHANICAL AND SEMICHEMICAL PULP MANUFACTURE OF IMPROVED POPULUS WOOD IN KOREA.] Res. Rep. For. Res. Inst. 21: 171-186. Ref. Eng. sum. [Kor.e.]

Laundrie, J. F., and Berbee, J. G. 1972. HIGH YIELDS OF KRAFT PULP FROM RAPID-GROWTH HYBRID POPLAR TREES. USDA Forest Service Research Paper, Forest Products Laboratory, Madison No. FPL 186, 23 pp. [E., 8 ref.]
Sulphate pulps were made from whole trees, 1, 3, 5, 11, and 24 years old of a natural hybrid Poplar clone resembling Populus deltoides and tentatively designated as P. X euramericana cv. 'Wisconsin 5', in Wisconsin.

Lengyel, P. 1967. [THE USE OF HUNGARIAN HARDWOODS IN THE PAPER INDUSTRY.] Papiripar, Budapest 11 (3): 83-91. [5 refs. [Hu.hu.g.ru.] N.L.L.]
Includes data on pulping properties and/or chemical composition of various Poplars (which were found to be the most suitable of the species tested for chemical pulp), Beech, Hornbeam, Alder, Oak, Turkey Oak and Robinia, the strength of semichemical pulp made from Beech + Hornbeam (suitable) and Beech + Turkey Oak (rather poor), etc.

Lengyel, P., and Hajduczky, G. 1964. PAPER TECHNOLOGICAL INVESTIGATION OF FAST GROWING POPLAR. Translation, Environment Canada (1972) No. OOENV TR 106, 10 pp. [E., 2 ref. Translation from Papiripar 8, 125-129. Hu.de. Limited distribution.]
Describes the chemical composition of the wood of four fast-growing cultivars planted in Hungary (Populus 'Marilandica', P. 'Scrotina', P. 'Robusta' and P. 'I-214'), compares it with that of the wood of P. nigra, P. alba and P. tremula, and gives tables and graphs showing the characteristics of the raw pulp from these Poplars.

McGovern, J. N., Laundrie, J. F., and Berbee, J. G. 1973. ASSESSMENT OF A RAPID-GROWTH HYBRID POPLAR FOR KRAFT PULPING. Univ. Wis. For. Res. Notes. 180, 5 p.

Markov, I. G., and Macelo, V. G. 1968. [THE USE OF POPLAR WOOD IN THE PULP AND PAPER INDUSTRY.] Bumaz. Prom., Moskva (5), (8-10). [9 refs. [Ru.ru.e.] N.L.L.]
Gives tabulated results of studies at Kiev on Poplar species and hybrids, showing stem height and diam., bark thickness and fibre dimensions at 5 years (hybrids) and 5-15 years (Populus alba, P. nigra and P. X 'canadensis'), the chemical composition of the wood, pulp properties, cooking conditions for sulphate and bisulphite pulps, and the effect of varying the proportion of Poplar to softwoods in mixed pulps.

Marton, R., et al. 1965. MORPHOLOGICAL LIMITATIONS TO THE QUALITY OF GROUNDWOOD FROM HARDWOODS. Tappi 48 (7): 395-8. 12 refs.
The influence of fibre length, transverse dimensions, and vessel elements on pulp properties was investigated on 'stone' and 'refiner' groundwoods from Spruce and Poplar.

Marton, R., and Agarwal, A. K. 1965. PAPERMAKING PROPERTIES OF HARDWOOD VESSEL ELEMENTS. Tappi 48 (5): 264-9. 9 refs.
A process is described for separating vessel elements and fibres from kraft pulps of Quercus alba, Betula spp., and Populus spp., used in the determination of % by weight of vessel elements in the species studied and their paper-making properties in relation to the fibrous fraction.

Marton, R., and Alexander, S. D. 1964. PROPERTIES OF FIBER FRACTIONS FROM CHEMICAL AND MECHANICAL PULPS. III. COMPARISON OF POPLAR AND SPRUCE PULPS. Tappi 47 (11): 704-10. 24 refs.
Chemical and mechanical Poplar and Spruce pulps are compared and most of the differences attributed to the thinner cell-walls of Poplar and the presence of vessel segments in the Poplar pulp.

Marton, R., Stairs, G. R., and Schreiner, E. J. 1968. INFLUENCE OF GROWTH RATE AND CLONAL EFFECTS ON WOOD ANATOMY AND PULPING PROPERTIES OF HYBRID POPLARS. Tappi 51 (5): 230-5. [17 refs.]
Describes an analysis of sample discs from stems of 2 clones, each of 3 ramets, of Populus maximowiczii XP. trichocarpa, P. nigra cv. 'Betulifolia' X P. trichocarpa and P. deltoides X P. nigra cv. 'Caudina'.

Motiet, A. 1967. [PAPER-MAKING STUDIES.] Extr. from Rapp. Lab. For. Etat, Gembloux 1966, (1-53 + 6 tbls.). [F.]

Onisko, W. 1963. THE SULPHITE COOKING OF POPLAR WOOD IN THE VAPOUR-GAS PHASE WITH THE USE OF AMMONIA BASE. Przeglad Papierniezy, Lodz (10; 12), (309-12; 380-2). [Pol.] From abstr. in Polish tech. Abstr. (3-4), (Nos. 8779; 8917). [E.Ru.] P.R.

Schleicher, H., Jacopian, V., and Philipp, B. 1972. [INFLUENCE OF REACTION WOOD ON MANUFACTURE AND PROCESSING OF DISSOLVING PULPS.] Cellulose Chem. Technol. 6 (4):

15-420. [De.e., 6 ref.]
amples of normal and reaction wood of Poplar and Larch were ubjected separately and together to sulphite pulping and l/NaOH/hypochlorite bleaching. With neither species did the resence of reaction wood impair the production of dissolving pulp nd viscose with good filter values, provided that the influence of he reaction wood was taken into account during pulping.

ouzet, G. 1973. [THE USE OF POPLAR BY THE PAPER NDUSTRY.] Report of the Regional Poplar Congress, Wageningen, he Netherlands. [F.e.]

Jprichard, J. M. 1968. PULPING OF POPULUS SPECIES. Extr. rom Rep. For. Res. Inst. N. Z. For. Serv. 1967, (73-4).
eports tests on 25-year-old trees of P. X regenerata, P. X eugenei, nd P. X robusta. Kraft pulps were obtained in screened yields of 3-57% from all three species.

Jprichard, J. M. 1968. PULPING STUDIES ON POPLARS: KRAFT AND BISULFITE PULPING OF POPULUS SPECIES. I. Z. For. Res. Inst. Forest Products Report 257 (unpublished).

Jprichard, J. M. 1971. PULPING STUDIES OF NEW ZEALAND ;ROWN POPLARS. Appita 24 (4): 261-6. [13 refs.]
'he pulping properties of New Zealand-grown Populus X robusta, P. C serotina, P. X regenerata and P. X eugenei when pulped by the ulphate and bisulphite processes were examined under laboratory onditions.

/ecchi, E. 1969. QUALITY CONTROL OF POPLAR GROUND-VOOD: FACTORS RELATED TO THE STRUCTURAL COM 'OSITION OF THE PULP. Tappi 52 (12): 2390-9. [9 refs.]
Aorphological analysis of Poplar groundwood (from cultivars of 'opulus X euramericana and P. deltoides) revealed the presence of everal ribon-like fibrous particles from tension wood.

/ecchi, E. 1970. [THE CHARACTERIZATION OF POPLAR 'ULP.] Cellulosa e Carta 21 (2): 24-43. [It.f.e.g., 9 refs.]

Roth, L., and Weiner, J. 1964. CONSTITUTION AND PULPING)F ASPEN AND POPLAR WOODS. Bibliographic Series, Institute)f Paper Chemistry, Appleton, Wis. No. 184 (Suppl. No. 1), pp. 49. [328 refs.]
nformative abstracts covering the period 1955-56 to 1962-63, listed)y author and with subject (including species) index.

862 COMPOSITE MATERIALS MADE WHOLLY OR PARTLY OF WOODY MATTER

Anonymous. 1971. [HUNGARIAN RESEARCH ON FIBRE BOARD, CHIP BOARD, AND COMPOSITE ASSEMBLIES PLYWOOD AND LAMINATED BEAMS).] Faip. Kutatas. 1970 51-81, 95-202). [Hu.ru.e.de., PR]
Papers on this subject include: Increasing the use of Hybrid Poplars 'or plywood manufacture (P. Csizmadia, T. Fabian, and V. Zoller; 17 ref.) [including trials on veneer cutting, drying, gluing, pressing, nd physical and mechanical properties of plywood from different :ultivars].

Arato, I. 1974. [SOME RESULTS OF RESEARCHES IN CONNEXION WITH THE DEVELOPMENT OF THE PARTICLE-BOARD AND SAWMILLING INDUSTRIES.] In Faipari Kutatasok)p. 147-164. [Hu.ru.e.de., 18 ref. TRADA]
Summarizes investigations in Hungary into the best utilization of nome-grown Poplar, with special reference to the possibility of using nodern technology (e.g. German machinery) and the use of defibrated chips in the surface layers of particle board intended for the furniture industry.

Carre, J., and Fraipont, L. 1967. [STUDIES ON PARTICLE- AND FIBREBOARDS.] Extr. from Rapp. Lab. For. Etat, Gembloux 1966, (61-221 + 15 gphs., 20 tbls.). [F.]
Consists of four chapters by the first author and two by the second: (1) The extrusion of particle boards; (2) The effect of varnishing on the behaviour of particle boards in moist conditions; (3) The effect of heat treatment on the physical properties of particle boards; (4) The relation between swelling of particle boards in damp air and when immersed in water; (5) The suitability of native Belgian species for the manufacture of fibreboards (studies on Poplar – not further specified – and Beech); and (6) The influence of $_pH$ on the physical and mechanical properties of fibreboards.

Carre, J., and Fraipont, L. 1969. [PARTICLE BOARDS.] Extr. from Rapp. Sta. Tech. For., Gembloux 1968, (75-326). [F., 11 refs.]

Fraipont, L. 1969. [THE SUITABILITY OF NATIVE [BELGIAN] SPECIES FOR THE MANUFACTURE OF FIBREBOARD. PART 3.] Extr. from Rapp. Sta. Tech. For., Gembloux 1968, (332-401). [F.]

Giordano, G. 1973. [TRENDS IN THE USE OF POPLAR WOOD FOR THE MANUFACTURE OF PARTICLE AND FIBRE BOARD.] Report of the Regional Poplar Congress, Wageningen, the Netherlands. [F.]

Gulyas Kiss, E., Harsanyi, I., and Vamos, R. 1968. [PRESSING OF PARTICLE BOARDS BY THE RELAXATION METHOD.] Faip. Kutatas., Budapest (1), (179-93). [9 refs. [Hu.hu.ru.e.g.] P.R.]

Kim, C. Y., and Goring, D. A. I. 1974. COMPOSITE HARDBOARD FROM POPLAR FIBRE AND POLYETHYLENE. Cellulose Chemistry and Technology 8 (4): 401-407. [E.ru., 15 ref. BLL]
Describes the experimental production of fibreboard from a mixture of air-dry pressure-refined Poplar fibre and powdered polyethylene.

Pavelescu, I. M., and Pridie, M. 1964. [SPECIFICATION FOR GRADING SOFT AND HARD WOODS FOR THE MANUFACTURE OF PARTICLE BOARD.] Stud. Cere. Inst. Cere. For., Bucuresti 24, (339-60). [Ro.ru.g.e.]
Deals with the principal defects found in Willow, Poplar, Lime and Beech wood, and the acceptable %'s of each defect.

Petrovic, S. 1967. [INVESTIGATIONS ON THE PRODUCTION AND PROPERTIES OF LIGHT PARTICLE BOARDS.] Drvna Ind. 18 (8/9): 143-52. [7 refs. [Serb.e.].]
Boards of 0·3, 0·4 and 0·5 g/c.c. were made of Silver Fir, Beech, and Poplar, using different amounts of glue and water repellents. The effects of the variables on board properties are shown in tables and graphs.

Pridie, M., et al. 1965. [THE POSSIBILITY OF USING LIME WOOD FOR PARTICLE-BOARD MANUFACTURE.] Stud. Cere. Inst. Cere. For., Bueuresti 25, (347-62). 6 refs. [Ro.e.g.ru.]
Experiments have shown that 20% of Lime (Tilia spp.) chips may be added to Willow and Poplar. Lime should not be mixed with Beech.

Shin, D. S. 1970. [STUDIES ON THE HARDBOARD FROM BRANCHES OF POPLAR TREE (POPULUS EURAMERICANA).] J. Jap. Wood Res. Soc. 16 (2): 60-4. [Jap.e., 8 refs. P.R.]
The effects of defibration time on yield and freeness of Asplund pulp, and of defibration and pressing times on sp. gr., strength properties, water absorption, swelling and dimensional stability of the hardboard were studied.

Shen, K. C. 1973. STEAM-PRESS PROCESS FOR CURING PHENOLIC-BONDED PARTICLEBOARD. Forest Products Journal 23 (3): 21-29. [E., 25 ref.]
Describes a new pressing process in which high-pressure steam is injected through the mat surface, by means of specially designed press platens and a sealing frame, to cure the resin binder rapidly.

Stegmann, G., Durst, J., and Kratz, W. 1965. [POPLAR CORDWOOD AS RAW MATERIAL OF THE PARTICLEBOARD INDUSTRY.] Holzforsch. u. Holzverwert., Wien 17 (3): 37-43. 21 refs. [G.g.e.] P.R.
Gives data on the increasing amounts of Poplar wood becoming available in W. Germany, and describes laboratory investigations on the manufacture, testing, and properties of single- and 3-layer boards made of Poplar, Beech, and mixtures of the two.

Syska, A. D. 1969. EXPLORATORY INVESTIGATION OF FIRE-RETARDANT TREATMENTS FOR PARTICLEBOARD. U.S. For. Serv. Res. Note U.S. For. Prod. Lab., Madison No. FPL-0201, pp. 19 + 3 figs., 9 tbls. [16 refs.]
Flake-type particle boards of Douglas Fir and Aspen were made with combinations of common fire-retardant chemicals applied in several ways, and evaluated for flammability, mechanical strength and dimensional stability.

863 WOOD HYDROLYSIS. SACCHARIFICATION

Krestan, E. S., Ul'yanovskaya, R. I., Varshavskaya, K. N., Miroshnichenko, V. G., and Savchenko, I. F. 1974. [STUDY OF

NEW SPECIES OF WOOD AS RAW MATERIAL FOR THE HYDROLYSIS INDUSTRY.] Gidroliznaya i Lesokhimicheskaya Promyshlennost' No. 7, 7-10. [Ru., 6 ref. BLL]
Gives the results of studies on the chemical composition and hydrolysis yields of wood of Salix alba, Elm, Poplar, Maple and Alder hydrolysed separately or in various mixtures with Aspen, Birch, Pine and Spruce. The Willow, Elm, Poplar, Maple, and Alder were all difficult to hydrolyse, but the presence of up to 10-15% of these species in the mixture did not significantly affect the density of the charge. When Willow, Elm and Poplar are used separately, a reduction of 10-15% in the yield of reducing substances can be expected. A content of up to 25% Willow, Elm and Poplar in the raw-material mixture will give the planned yield of reducing substances, with satisfactory quality of the hydrolysates.

Tokarev, B. I. 1974/1975. [HYDROLYSIS OF POPLAR WOOD.] Topola 18/19 (103/106): 86-87. [Sh.e.ru.]
Summarizes a trial in the USSR on the hydrolysis of Poplar wood (grown in the Leningrad region) compared with sunflower stalks, Betula verrucosa and other species.

89 OTHER FOREST PRODUCTS

892 VEGETABLE PRODUCTS

892.1

Kudasheva, A. V., and Shestak, S. S. 1973. [AMINO-ACID COMPOSITION OF BROWSE AS FODDER.] Zhivotnovodstvo No. 9, 44-45. [Ru.] From Herbage Abstracts 44, 2020.
Data are presented for the crude protein and amino-acid contents in the shoots and leaves of Populus spp., Ulmus spp., Tilia sp., Fraxinus sp., Acer sp., Acacia sp. and Betula sp.

892.4

Murko, D. 1965. [EXTRACTIVES FROM POPLAR BARK AND THE POSSIBILITY OF OBTAINING THEM.] Pregled naucnoteh. Rad. Inform. Zavod Tehn. Drveta, Sarajevo 2 (4): 39-43. 25 refs. [Serb.g.] P.R.
Gives results of extraction of the bark of 7 different Poplar species and hybrids with warm water, with data on the extractives obtained – mainly tannins and carbohydrates.

Pearl, I. A. 1968. EXTRACTIVES OF HARDWOOD WASTES AS SOURCES OF CHEMICALS. For. Prod. J. 18 (2): 60-2. [20 refs.]
Cf.F.A. 29 No. 1634.] Reviews recent developments in the isolation, identification and utilization of pharmaceuticals and other chemical compounds from the bark and leaves of Populus and Salix spp.

Pearl, I. A. 1969. WATER EXTRACTIVES OF AMERICAN POPULUS PULPWOOD SPECIES BARKS – A REVIEW. Tappi 52 (3): 428-31. [26 refs.]

Pearl, I. A., and Darling, S. F. 1968. MASS SPECTROMETRY AS AN AID FOR DETERMINING STRUCTURES OF NATURAL GLUCOSIDES. [STUDIES OF BARKS OF THE FAMILY SALICACEAE NO. IV; STUDIES OF THE LEAVES OF THE FAMILY SALICACEAE NO. 10.] Phytochemistry, Oxf. 7 (5): 831-7. [15 refs. O.R.S.]
Mass spectral fragmentation patterns were determined for a number of glucosides of known structure from bark and leaves of Salix and Populus spp.

Pearl, I. A., and Darling, S. F. 1970. THE STRUCTURES OF SALICORTIN [FROM BARK AND LEAVES OF VARIOUS SALIX AND POPULUS SPP.] AND TREMULACIN [FROM BARK OF P. TREMULOIDES]. Tetrahedron Lett. (44), (3827-30). [E., 8 refs. O.R.S.] [Cf. F.A. 32 No. 5148.]

Pearl, I. A., and Darling, S. F. 1971. THE STRUCTURES OF SALICORTIN AND TREMULACIN. Phytochemistry 10 (12): 3161-3166. [E., 12 ref. ORS]
Reports the structure of the labile glucoside, salicortin, an important component of the bark and leaves of all Populus and Salix species, and of tremulacin, an important glucoside component of several Populus species, which was demonstrated to be the 2-O-benzoyl ester of salicortin.

Porta-Puglia, A., and Jodice, R. 1973. [HUMIFICATION OF POPLAR BARK PILES. I. CHANGES IN SOME CHEMICAL AND MICROBIOLOGICAL CHARACTERISTICS IN A PILOT PLANT.] Allionia 19, 51-63. [It.e., 11 ref. BLL.]
Describes changes in the microflora and chemical composition of an experimental pile of Poplar bark during a 10-month period.

Thieme, H. 1964. [THE CONSTITUTION OF SALIREPOSIDE.] Naturwissenschaften 51 (12): 291. 7 refs. [G.] O.R.S.
Isolated from barks of Poplars and Willows.

892.5

Halbinger, R. E., and Mussini, J. C. 1974. [CULTIVATION OF THE SHIRATAKE EDIBLE FUNGUS (LENTINUS EDODES) ON POPLAR WOOD.] Revista Forestal Argentina 18 (2): 53-54. [Es.]
A note describing the successful cultivation of the Japanese Hiratake variety of L. edodes on Poplar logs in Argentina.

892.62

Wollenweber, E., and Chadenson, M., et al. 1973. [A NATURAL FLAVONONOL ACETATE [THE 3-ACETYL DERIVATIVE OF PINOBANKSIN] IN THE BUD OIL OF POPLAR SPECIES.] Zeitschrift fur Naturforschung 28c (638-640). [De. From Berichte Biochemie und Biologie (1975) 412, 980. De.]

9 FORESTS AND FORESTRY

FROM THE NATIONAL AND INTERNATIONAL POINTS OF VIEW

90 GENERAL

Anonymous. 1971. NATIONAL REPORT ON ACTIVITIES RELATED TO POPLAR & WILLOW CULTIVATION. Exploitation & Utilization- India- 1968-70. Mini. of Agri. Govt. of India New Delhi May, 1971.

Allegri, E. 1971. [IDENTIFICATION OF SPECIES AND VARIETIES OF POPLAR INDIGENOUS IN ITALY.] Annali dell'Instituto Sperimentale per la Selvicotura, Arezzo 2, (1-62). [It.f.e., 21 ref.]

Bornand, G. H. 1974. [SWISS POPULATION OF POPLARS; 1973 NATIONAL REPORT.] Mitt. Schweiz. Pappel. Arbeitsgen. 24: 3-4. [F.]

Brown, A. G. 1973. PROGRESS IN POPLAR GROWING IN AUSTRALIA TO JUNE 1965. Technical Note, Forestry & Timber Bureau, Australia No. 5, 5 pp. [E., 7 ref.]
A reprint of the statement by Australia for the International Poplar Commission, 1965, reporting briefly on the extent of Poplar plantations in Australia at the time (ca. 800 acres), insect damage, diseases, growth rates, and development of new clones.

Chardenon, J. 1971. [THE POPLARS OF TURKEY.] Rev. for. franc. 23 (2): 263-72. [F.es., 13 ref.]
Outlines the geography and climate of Turkey, and describes the extent of Poplar-growing there and its limitations, especially the need for irrigation because of the severe summer drought.

FAO. 1969. [THE TURKISH POPLAR INSTITUTE. VOL. 2. TECHNICAL REPORT.] FAO, Rome. pp. ix + 655 + 3 figs. [F.]

Hellinga, G. 1968. [POPLAR RESEARCH IN THE NETHERLANDS.] Populier 5 (1): 14-15. [Du.]

Meiden, H. A. van der. 1973. [THE NATIONAL POPLAR COMMISSION OF THE NETHERLANDS.] Populier 10 (2): 24-25. [Du.E.f.]

903 FOREST POLICY, GENERAL: GENERAL SYSTEMS, PROGRAMMES, PLANS, ETC.

Hartog, G. J. den. 1973. [FORESTRY POLICY AND POPLAR GROWING.] Populier 10 (2): 34-37. [Du.E.f.]

904 GENERAL REGIONAL ACCOUNTS OF FORESTS AND FORESTRY

Anonymous. 1966. [SPECIAL ISSUE ON [GREEK] MACEDONIA.] Das. Chron. 8 (8/9): 343-393. [Gk.]

Cherkasova, G. I., and Cherkosov, I. K. 1970. [THE ASPEN ON THE CHALK HILLS IN WESTERN KAZAKHSTAN.] Moscow Univ. Vestnik Ser. 6 Biol. Pochvoved 6: 57-59. [Ru.]

Claudel, Y. 1972. [POPULUS CULTURE BY PRIVATE OWNERS IN THE RHINE-ALPS REGION.] For. Fr. Act. For. 169: 32-34. [F.]

Cuccaro, R., and Ascoli, A. 1972. [DEMONSTRATIONS GIVEN BY THE ENCC [NATIONAL PULP AND PAPER CORPORATION] IN THE POPLAR-GROWING SECTOR.] Cellulosa e Carta 23 (12): 29-35. [It.]
Briefly reviews the activities of the Corporation during 1972, with tabulated data showing the areas of N. and of central and S. Italy treated by spraying against attacks by Marssonina brunnea and by insects, and the work done on stump-grubbing and digging planting holes.

Evans, A. S. D. 1973. REPORT ON POPLARS IN SOUTH CANTERBURY. South Canterbury Catchment Board, Timaru, N.Z. (unpublished): 22 pp.

Giordano, G. 1969. SHORT NOTES ON POPLAR CULTURE IN THE FAR EAST – JAPAN. Cellulosa e Carta 20 (3): 68-75. [It.]

Griffioen, K. 1973. SURVEY OF THE NATIONAL REPORTS OF THE PARTICIPATING COUNTRIES. Report of the Regional Poplar Congress, Wageningen, the Netherlands.
The countries participating at the Regional Congress on the poplar wood market, held in Wageningen from 7-10 May, 1973, presented reports on their poplar wood production, consumption and trade. The author compiled the data from these reports.

Kohan, S. 1972. [RESULTS IN POPLAR CULTIVATION IN THE IRON AND STEEL AREA OF EASTERN SLOVAKIA.] Les. (Bratislava) 28 (1): 3-9. [Slovak.]

Kohan, S. 1972. [RESULTS SO FAR IN GROWING POPLARS IN INTENSIVELY MANAGED PLANTATIONS ON THE E. SLOVAKIAN PLAIN.] Vedecke Prace Vyskumneho Ustavu Lesneho Hospodarstva vo Zvolene 15, 63-84 [Sk.ru.e.de., 12 ref.]
A report on experience in Poplar cultivation on the E. Slovakian plain, comparing the performance and susceptibility to disease of Populus 'I-214', P. 'Robusta', P. 'Gelrica' and P. 'Virginiana de Trignicourt' in plantations 2-12 years old, and discussing methods of site preparation where soils are heavy.

Laar, A. van, and Tingle, A. C. M. 1965. [CULTIVATION OF POPLARS IN SOUTH AFRICA.] Tijdschrift der Koninklijke Nederlandsche Heide Maatschappij 76 (9): 374-384. [Du.]

Meiden, H. A. van der. 1973. THE POPLAR AND WILLOW AREA IN THE NETHERLANDS. Populier 10 (2): 37-40. [E.f.]

Mottl, J. 1971. POPULUS CULTURE IN CZECHOSLOVAKIA. Gorsko Stopanstvo 27 (7): 49-52. [Bulg.]

Mutibaric, J. 1970. PROBLEMS OF POPLAR CULTIVATION IN MEMBER COUNTRIES OF EEC. Topola 14 (77/78): 34-41. [Croat.]

Nielsen, R. C. 1965. POPLARS IN AUSTRALIA. Paper to the 4th Conference of the Inst. of Foresters of Aust., Hobart. 10 pp.

Nikolaishvili, R. V. 1974. [PLANTATION WORK IN FORESTRY IN COLCHIS.] Subtropicheskie Kul'tury No. 6, 62-65 [Ru., BLL]
A general account of forestry in the Colchis region (the 'subtropical' coastal lowlands of Soviet Georgia), with special reference to the development of plantations. In the period 1947/73, some 1759 ha have been planted, of which 1312 ha survive. The main species used are Poplars, Eucalypts, Platanus orientalis, Robinia pseudoacacia and Pinus pinaster.

Ponticelli, P. 1973. [THE ASSOCIATION FOR POPLAR CULTURE OF CARTIERE RIUNITE DONSELLI AND MERIDIONALI: GUSSOLA, BREME AND BOSCONE.] Cellulosa e Carta 24 (1): 25-40. maps. [It.]

Porcelli, G. S. 1974. [FENIGLIA IN HISTORY.] Monti e Boschi 25 (2): 33-36 [It.]
Gives a short historical account of the past and present vegetation of Feniglia, the narrow strip of sand-dunes that separates the Mediterranean from the lagoon of Orbetello on the west coast of Italy.

Pourtet, J. 1970. PROGRESS IN POPLAR CULTURE. Schweiz Pappel-arbeitsgemeinsch Mitt 18: 1-4. [F.]

Ruedi, K. 1972. [POPLAR PLANTATIONS IN THE FOURTH AARAU FOREST DISTRICT.] Schweiz Pappel-arbeitsgemeinsch Mitt. 21: 1-9. [F.]

Schaefer, N. T. 1969. COMMERCIAL POTENTIAL OF POPLARS ON THE NORTH COAST OF NEW SOUTH WALES. Univ. New England, Armidale. Dept. of Univ. Extn. Res. Ser. in Regional Devt. 3.

Soofi, G. R. 1970. POPLAR CULTIVATION IN KASHMIR VALLEY & ITS ECONOMIC APPRAISAL. J & K State Forestry Conference, Srinagar, October, 1970, pp. 32.

Szanto, G. 1972. [POPLAR STANDS IN SOMOGY.] Erdo 21 (2): 61-64. [Hu.]

Tsitsones, K., and Garphallos, I. 1971. [POPLAR CULTURE IN WESTERN EUROPE.] Dassika Chron 13 (155/156): 50-62. [G.]

Zundel, Rudolf. 1972. PAPPELANBAU IM RAHMEN DER LANDESPFLEGE. Holzzucht, Reinbek 26 (3/4): 34-38, [6 Abb.]

905 FOREST STATISTICS AND RESOURCES

Anonymous. 1969. WECHSELBERGER: PAPPELINVENTUR, ABER WIE? Holzzucht, Reinbek 23 (1): 6-9, [1 Tab.]

Bozic, J. 1971. [PLANTATION PRODUCTION OF POPLAR WOOD IN YUGOSLAVIA.] Les. (Ljubljana) 23 (3/4): 43-46. [Slv.]

Brodbeck, C. 1974. [POPLAR GROWING IN SWITZERLAND. REPORT ON THE 1970/71 SURVEY.] Der Pappelanbau in der Schweiz. Bericht uber die Erhebung 1970/71 [Bern, Switzerland;] Schweizer Pappel-Arbeitsgemeinschaft. [De. from Holzzucht 28, 24. De.]
The survey recorded all Poplar stands (including rows $\geqslant$ 100 m long) on a map (1 : 50,000), giving information on total area, distribution, age groups, volume/ha, etc., and listing the clones most frequently planted.

Jerome, R. 1966. [AN INVENTORY OF POPLAR STANDS.] Erdo 15 (9): 410-6. [Hu.ru.g.]
Includes data for Hungary on age distribution and predicted increases in annual cut in the period to 1974/75.

Joris, D. 1974. [SOME RECENT STATISTICS ON POPLAR [GROWING IN BELGIUM].] Bulletin de la Societe Royale Forestiere de Belgique 81 (4): 177-187 [F.Nl., Cf. FA 35, 4856]

Kottasz, T. 1968. [CHANGES IN THE AREA UNDER POPLARS IN HUNGARY.] Erdo 17 (9): 409-11. [3 refs. [Hu.] 3 figs. 1 tbl.]
Compares the total area under Poplars and Willows in 1885 (141,271 ha.), 1933 (48,330), and 1966 (77,603) and its distribution by districts and river flood-plains.

Krzysik, F., and Milewski, J. 1970. [TRENDS IN THE INDUSTRIAL UTILIZATION OF POPLAR WOOD.] Sylwan 114 (5): 45-57. [Pol.ru.e., 15 refs.]
Reviews Poplar planting in Poland since 1951, with data on present annual production (57,400 cu. m.) and estimated annual yields up to the year 2000 A.D. (> 2-1/2 million cu. m.).

Meiden, H. A. van der. 1967. [POPLARS AND WILLOWS IN THE NETHERLANDS – FOREST STATISTICS.] Populier, Wageningen 4 (3;4): 46-8; 56-9. [Du.]
Gives general statistics of forest area, ownership, species, age, yields from forest areas and roadside and boundary plantings, etc., and tables showing the distribution of Poplar and Willow plantings by districts, their soil types, volume and increment per ha. of Poplar

plantings, and ownership classes and distribution of volume by diam. class for roadside and boundary plantings of Poplar and Willow.

Meiden, H. A. van der. 1971. [POPLARS AND WILLOWS IN THE NEW [NETHERLANDS] FOREST STATISTICS.] Populier 8 (3): 43-7. [Nl.]
A statistical survey comparing data from the official forest statistics collected in 1964-68 with those of an earlier survey.

Rossmassler, W. 1968. [[W. GERMAN] POPLAR INVENTORIES.] Holzzucht, Reinbek 22 (3): 21-5. [G.]
Discusses data on Poplars grown in forest stands, extracted from: the W. German forest census of 1961; a survey of Poplars planted inside and outside the forest in Rheinland-Westphalen, 1958/59; a survey in progress in Baden-Wurttemberg; and suggestions for a country-wide survey of Poplars and Willows in W. Germany.

907 INDIRECT SIGNIFICANCE OF FORESTS

Anonymous. 1972. [LANDSCAPE CONSIDERATIONS IN THE CONSOLIDATION OF FRAGMENTED HOLDINGS.] Holzzucht 26 (1/2): 1-20 [De.]

Becher, R. 1970. VON PAPPELN OHNE RINDE UND SOLCHEN MIT SEELE. Holzzucht, Reinbek 24 (4): 44-46.

Grandjot, W. 1968. PAPPEL, FREMDKORPER IN DER LANDSCHAFT? Forst-Holzwirt, Hann. 23 (11): 229-230. [5 Abb.]

Keller, T. 1974. [FILTERING EFFECT OF HEDGES ON AIR-POLLUTANT DUSTS CREATED BY ROAD TRAFFIC, ESPECIALLY LEAD COMPOUNDS.] Schweizerische Zeitschrift fur Forstwesen 125 (10): 719-735 (De.f., 53 ref.]
Pieces of spagnum moss or glass wool were exposed near the ground for a few weeks, with overhead protection, at various distances from several busy roads in Switzerland, one being a motorway without hedges and the others being lined with hedges ca. 1 m wide of Carpinus betulus or Thuja plicata, a Poplar screen or the margin of a mixed hardwood stand.

Salmi, M. 1965. [ART, LANDSCAPE, AND FOREST.] Ital. for. mont. 20 (6): 237-54 + 20 photos. 18 refs. [It.f.]

Sollie, J. F. 1969. [BIRDS IN POPLAR-PLANTATIONS.] Populier 6 (2): 31-33. [Du.]

Vilaclara Mir, L. 1972. [FORESTS OF CATALONIA; THE SIGNIFICANCE OF INDIRECT BENEFITS.] Agric. Rev. Agropecu 41 (486): 649-651. [Span.]

907.2

Roorda van Eysinga, N. P. H. J. 1967. [POPLAR FOREST AND RECREATION.] Populier 4 (1): 2-6. [Du.]

Meiden, H. A. van der. 1966. [POPLAR FOREST AND RECREATION.] Publication by the "Vereeniging van Nederlandsche Papierfabrikanten", Haarlem. [Du.]

91 LAND USE, LAND-USE POLICY, AFFORESTATION POLICY

915 TIMBER-GROWING OUTSIDE THE FOREST (e.g. ROADSIDE STRIPS)

Jaeger. 1971. PAPPEL-ANBAUTEN EINER PAPIERFABRIK UND IHRE BEDEUTUNG FUR LANDSCHAFT UND WIRTSCHAFT. Forst-Holzwirt, Hann. 26 (13): S.262, [1 Lit. Ang.]

Lange, O. 1964. PAPPELN ALS HELFER BEI DER BEGRUNUNG VON INDUSTRIEANLAGEN. Holz-Zbl., Stuttg. 90 (34): S.607, [Abb.]

Lange, O. 1973. PRODUKTION UND PREISENTWICKLUNG AUF DEM EUROPAISCHEN PAPPELMARKT. [PRODUCTION AND PRICE DEVELOPMENT ON THE EUROPEAN POPLAR MARKET.] Holzzucht, Reinbek 27 (2/3): 17-20, [1 graph. Darst., 4 Tab., 26 Lit. Ang.]

Rossmassler, W. 1967. 20 JAHRE FLURHOLZANBAU UND PAPPELWIRTSCHAFT. Allgem. Forstz., Munchen 22 (23): 404-406, [6 Abb.]

Schmitz-Lenders, B. 1965. BEMERKUNGEN ZU DEN IM SONDERHEFT DES "FORST- U.HOLZWIRT" VOM 16.6.1964 VEROFFENTLICHTEN AUSFUHRUNGEN BETREFFEND DEN ZENTRALEUROPHAISCHEN PAPPEL-KONGREB. Forst- u. Holzwirt, Hann. 20 (12): 265-267, [4 Lit. Ang.]

Wechselberger. 1970. FLURHOLZANBAU UND PAPPELWIRTSCHAFT. Holzzucht, Reinbek 24 (2/3): 17-19.

93 PUBLIC SUPERVISION AND REGULATION OF FORESTRY, INCLUDING LEGISLATION FOR THESE PURPOSES

Albertini, F. 1970. [RECENT LEGISLATION ON AGRICULTURAL CONTRACTS; FAIR RENT, DIRECT GROWER, LEASE, METAYAGE, LONG LEASE GROUND RENT, TRIBUTARY ASSISTANCE FOR POPLAR CULTURE.] Milano, Pirola 223 p. [It.]

Meiden, H. A. van der. 1968. [THE LEGAL OBLIGATION FOR REFORESTATION AND THE PROFITABILITY OF POPLAR PLANTATIONS.] Populier 5 (2): 29-31. [Du.]

94 METHODS TO IMPLEMENT FOREST POLICY

945 ADVISORY SERVICES; PUBLICITY; EDUCATION; RESEARCH

Ludwig, H. A. 1971. [GOVERNMENTAL AID MEASURES FOR PLANTING POPLAR AND WILLOW.] Populier 8 (3): 48-49. [Du.]

945.4

Anonymous. 1964. FIFTEEN YEARS FOREST RESEARCH IN ISRAEL. La-Yaaran 14 (4): 144-143. [E.]

Anca, T. 1971. [RESEARCH PROGRAM ON THE CULTURE OF POPLARS AND WILLOWS.] Rev. Padurilor 86 (5): 259-261 [Rum.]

Vallee, G. (Co-ordinator). 1972. [RESEARCH AND DEVELOPMENT ON POPLAR IN THE EASTERN QUEBEC REGION. I – RESEARCH PROGRAMME [OF THE QUEBEC POPLAR RESEARCH GROUP].] Memoire, Service de la Recherche, Ministere des Terres et Forets, Quebec No. 8, 115 pp. [F.e., 14 ref.]

Zabielski, S. 1974. [EUROPEAN INSTITUTES CARRYING OUT RESEARCH ON POPLARS.] Sylwan 118 (1): 33-43. [Pol.ru.e., 4 ref.]
Gives notes on the lines of Poplar research being carried out in Belgium, Bulgaria, Czechoslovakia, France, Holland, Hungary, Italy, Poland, Rumania, Turkey, West Germany and Yugoslavia.

946 ASSOCIATIONS, SOCIETIES; CONFERENCES; INSTITUTIONS

Anonymous. 1969. [PROCEEDINGS OF THE POPLAR AND ARBORICULTURE OF TIMBERDAY (PADOVA, MARCH 1, 1969).] Agr. Venezie 23 (3): 179-272 [It.]

946.1

Dimitrijevic, Z., Bura, D., et al. 1971. [REPORT ON THE ACTIVITY OF THE YUGOSLAVIAN NATIONAL POPLAR COMMISSION BETWEEN THE TWO SESSIONS OF THE INTERNATIONAL POPLAR COMMISSION (FAO) IN THE PERIOD 1968-1970.] Topola 15 (83/85): 7-22. [Sh.e., 119 ref.]

946.2

Anonymous. 1966. [FIRST MEETING OF THE FORESTRY PLANNING SECTION OF INTA [INSTITUTO NACIONAL DE TECNOLOGIA AGROPECUARIA OF ARGENTINA]: BASIC DOCUMENTATION.] Idia: Supl. for. No. 3, (57-111). [Span.]

Anonymous. 1967. [THE FIRST FORESTRY SYMPOSIUM OF THE SOUTH [OF BRAZIL] – HELD AT THE FORESTRY

CHOOL OF THE FEDERAL UNIVERSITY OF PARANA, 8-12 IAY, 1967.] Companhia de Desenvolvimento Economico do arana (Curitiba?). pp. [63]. [Port.]

elitz, E. 1964. PAPPELFAHRT NACH OSTERREICH. Hess. /aldbesVerb., Wiesb. 12 (10): 85-86.

ange, O. 1964. STAND DER PAPPELWIRTSCHAFT IN ORDRHEIN-WESTFALON UND FRAGEN DES ANBAUES VON ALSAMPAPPELN. Holzzucht, Reinbek 18 (3/4): 26-27.

ann, W. 1964. JAHRESHAUPTVERSAMMLUNG DES EUTSCHEN PAPPELVEREINS, LANDESGRUPPE HESSEN E.V. orstl. Mitt., Bad Homburg v.d.H. 17 (16): 267-268.

946.3

nonymous. 1970. WACHSENDE BEDEUTUNG DER PAPPEL UR DIE TURKEI. Holz-Zentralbl., Stuttg. 96 (5): S.42

ekawin, M. 1964. TATIGKEIT UND ZIELE DES FORSCHUNGS-NSTITUTS FUR PAPPELWIRTSCHAFT IN CASALE ONFERRATO. Forst- u. Holzwirt, Hann. 19 (12): 260-262. Photogr.]

97 INTERNATIONAL FOREST POLICY AND OTHER INTERNATIONAL COLLABORATION

971 CONGRESSES AND CONFERENCES

nonymous. 1969. [THE 13TH MEETING OF THE INTER-ATIONAL POPLAR COMMISSION.] Cellulosa e Carta 20 (3): -75. [Many refs. [It.it.f.e.g.].]

nonymous. 1974/75. [INTERNATIONAL SYMPOSIUM ON OPLAR GROWING AND THE UTILIZATION OF POPLAR OOD, YUGOSLAVIA.] Topola 18/19 (103/106): 212 pp. Sh.e.ru., Many ref.]

Broekhuizen, J. T. M. van. 1969. [INTERNATIONAL REGISTRATION OF THE NAMES OF POPLAR CLONES IN MIDDLE- AND NORTHWEST EUROPE.] Populier 6 (5): 78-80. [Du.]
Information on the activities of the study-group concerned of the International Poplar Commission of FAO.

International Poplar Commission. 1971. [ISSUE DEVOTED TO THE XIVth SESSION OF THE INTERNATIONAL POPLAR COMMISSION (FAO).] Rev. Padurilor 86 (9): 451-92 + smries.). [Ro.e.f.es.]
[Cf. FA 30 No. 5498.] Presents the texts (many abridged) of 17 papers delivered by Rumanian nationals at a conference held in Bucharest from 27 Sept. to 2 Oct. 1971, on 'growing Poplars and Willows on sites liable to flooding'.

International Poplar Commission. 1971. NATIONAL REPORT ON ACTIVITIES RELATED TO POPLAR AND WILLOW CULTIVATION 1968-1970. XIV SESSION OF THE INTERNATIONAL POPLAR COMMISSION, BUCHAREST. New Zealand National Poplar Commission [National Plant Materials Centre, Palmerston North]. pp. 32. [13 ref.]
Includes statistical information, and information on: varieties; silviculture; breeding and genetics; injuries, diseases and pests, and protection against these; and miscellaneous topics.

International Union of Forest Research Organizations. 1964. EXCURSION IN THE NORTHERN ANATOLIA AFTER THE PERMANENT AND ENLARGED COMMITTEE MEETING IN ISTANBUL. International Union of Forest Research Organisations, Ankara. pp. 159 + 2 maps. [E.g.f.]
Includes descriptions of the Forest Faculty at Istanbul, the Poplar Research Institute at Izmit, several experimental forests, ranges, etc. [cf. F.A. 18 No. 2375], and various trials [cf. F.A. 20 No. 1830; 22 No. 4696].

Miller, W. A. 1972. [NOTES ON THE INTERNATIONAL POPLAR COMMISSION.] Timber Grow 46: 27-30.

P. ALBA TO P. BACHOFENI

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

11 SITE FACTORS: CLIMATE, SITUATION, SOIL, HYDROLOGY

111.1

opescu, I. G., Paun, R., et al. 1968. ALLERGY TO POLLEN RAINS IN CERTAIN REGIONS OF RUMANIA. Review of alaeobotany and Palynology, Amsterdam 7 (1): 55-9. [E., 12 refs. O.R.S.]
n most areas, the incidence of allergy is small, but in a ub-Carpathian region where it is higher, tree pollens, especially of opulus nigra, P. alba, and Tilia cordata, were found to be mportant.

111.2

Birkebak, R., and Birkebak, R. 1964. SOLAR RADIATION CHARACTERISTICS OF TREE LEAVES. Ecology 45 (3): 646-9. 13 refs.
The amounts of solar energy, reflected by, transmitted through, and absorbed by, the upper and lower leaf surfaces of 22 hardwood species in Minnesota were measured with an integrating sphere radiometer; results are tabulated.

114.2

Marzo, M. T. 1964. [RAPID ANALYSES APPLIED TO FOREST SOILS. DETERMINATION OF 'AVAILABLE' K.] Montes, Madrid 20 (118): 301-11. 4 refs. [Span.]
Tabulates results of analyses for available K % in samples of forest soils (supporting Pinus nigra var. calabrica, P. halepensis, P. pinea, P. pinaster, Quercus ilex, Q. suber, Q. lusitanica, Populus alba and P. nigra) from 8 Spanish provinces.

16 GENERAL BOTANY

160 PLANT CHEMISTRY

Bendz, G., and Haglund, A. 1968. POPULUS TREMULA THE ANTHOCYANINS OF LEAVES AND CATKINS. Acta chem. scand. 22 (4): 1365. [3 refs. [E.] O.R.S.]
Compares the anthocyanins (all cyanidin derivatives) found in spring, summer and autumn leaves, ♂ and ♀ catkins, and ♂ catkins of P. alba X P. tremula (which contained the same anthocyanins as ♂ catkins of P. tremula).

Portjanko, V. F., and Kostina, A. E. 1968. [CONTENT OF IODINE IN THE VEGETATIVE AND REPRODUCTIVE ORGANS OF PLANTS.] Fiziol. Rast. 15 (1): 135-8. [27 refs. [Ru.ru.e.] A.P.B.]
Tabulates and discusses the results of analyses made on 11 species, including Pinus sylvestris and Populus alba var. pyramidalis. [See Translations, Sect. 0.]

Schlenker, G., and Jeremias, K. 1968. [[SEASONAL PATTERNS IN CHEMICAL CONTENTS OF FOREST TREES IN RELATION TO BREEDING WORK.] [I] ARE THERE SPECIFIC 'INTERNAL CALENDARS' FOR THE TIMING OF BREEDING WORK? [II] CARBOHYDRATE CONTENTS IN THE FOLIAGE AND BARK OF THE [BALSAM] POPLAR CULTIVARS 'OXFORD', 'ROCHESTER' AND 'ANDROSCOGGIN'. [III] CHANGES IN

FAT CONTENT IN THE BARK OF THE POPLAR CULTIVARS 'OXFORD', 'ROCHESTER' AND 'ANDROSCOGGIN' IN THE COURSE OF A YEAR.] Mitt. Ver. Forstl. Standortskunde Forstpflzucht. No. 18, (88-97). [24 refs. [G.g.e.].]

Stoessl, A., Toth, A., Hardegger, E., and Kern, H. 1971. 7-0-METHYLAROMADENDRIN FROM POPULUS ALBA. Phytochemistry 10 (8): 1972-1973.

Szendrey, I., and Juhasz, M. 1966. COMPARATIVE TESTING OF THE LEAF-CATALASE OF SOME TREE SPECIES. Hungarian Forestry Science Review, Budapest (73-82). [E.]

Szendry, I., and Juhasz, K. 1966. [COMPARATIVE STUDIES ON LEAF CATALASE OF SOME TREE SPECIES.] Erdesz. Faipari Egyetem tud. Kozl., Sopron (1/2): 239-49. [6 refs. [Hu.ru.g.e.].]
Leaf catalase activity was studied during two years, and characteristic curves were derived for Quercus petraea, Q. robur, Q. cerris, Fagus sylvatica, Populus alba, and P. nigra. The curves provide a basis for determining the biological state of the tree.

161 PHYSIOLOGY

Domingo, I. L. 1972. PHYSIOLOGICAL RESPONSES OF AN ASPEN-POPLAR HYBRID TO TEMPERATURE AND SOIL MOISTURE TREATMENTS. [Abstract]. Dissertation Abstracts International, B 32 (10): 5560 [E., ORS, Order No. 72-12,545]
A controlled-environment study of rooted cuttings of Populus grandidentata X P. alba, in order to determine the effects of air temperature and soil moisture on photosynthesis, respiration, vegetative growth, dry weight, distribution of assimilates and leaf water content.

Domingo, I. L., and Gordon, J. C. 1974. PHYSIOLOGICAL RESPONSES OF AN ASPEN-POPLAR HYBRID TO AIR TEMPERATURE AND SOIL MOISTURE. Botanical Gazette 135 (3): 184-192 [E., 21 ref. OBD]
Reports a controlled environment study of rooted cuttings in which maximum net photosynthesis and height growth were recorded in the soil-moisture range 16-30%, and for day/night air-temperature regimes of 25°/15° and 30°/20° C.

Liani, A. 1972. [DISTRIBUTION OF P^{32} INJECTED INTO THE STEMS OF YOUNG POPLARS.] Pubblicazioni del Centro di Sperimentazione Agricola e Forestale 11 (4): 261-269 [It.e., 18 ref.]
The distribution of P^{32} was studied in potted plants of the clones Populus alba '49/51' (a), P. nigra '62/55' (b), P. deltoides 'UAS 235' (c) and P. X euramericana [P. X canadensis] 'I 214' (d) that had been treated by injection of $H_3P^{32}O_4$ into the stems.

Pospisl, J. 1966. SOME RESULTS FROM A STUDY OF MICROSPOROGENESIS IN THE PLUS-TREE OF POPULUS ALBA L. NO. 333. Sborn. Vysoke Skoly Zemed., Brno (Rada C) 35 (3): 225-32 + 4 plates. [11 refs. [E.e.ru.g.cz.cz.].]
Describes, and illustrates with photomicrographs, the cytology of microsporogenesis in a tree that had been found to form abnormally large pollen grains.

Tagirov, A. R. 1970. [THE TRANSPIRATION CAPACITY OF THE WOODY SPECIES GROWING ALONGSIDE CANALS IN THE GOLODNAJA STEPPE.] Lesoved. (2), (101-4). [Ru.e., 2 refs.]
Graphs the transpiration rates of Apricot [Prunus armeniaca?], Robinia pseudoacacia, Salix sp., Acer negundo, Populus bolleana [P. alba var. pyramidalis], and Fraxinus pennsylvanica in May, June, July, Aug., and Sept.

Tucovic, A., and Vuletic, D. 1969. [CHARACTERISTICS OF MEIOSIS IN NATIVE ASPEN AND WHITE AND BLACK POPLAR.] Topola, Beograd 13 (71/72): 21-5. [Serb.e., 21 refs.]
Describes and illustrates the main phases in Populus tremula, P. alba and P. nigra.

164 MORPHOLOGY

Sinclair, R., and Thomas, D. A. 1970. OPTICAL PROPERTIES OF LEAVES OF SOME SPECIES IN ARID SOUTH AUSTRALIA. Aust. J. Bot. 18 (3): 261-73. [18 refs., O.B.D.]
Gives measurements of reflection and transmission spectra (over the wavelength range 350-1350 nm.) for a number of species of the arid zone (including Eucalyptus oleosa, and Acacia spp.), and comparative data for some non-arid species (including Populus alba, Quercus cerris and E. macrocarpa).

165 PHYLOGENY, EVOLUTION, HEREDITY GENETICS, ETC.

Anonymous. 1969. [DISEASE-RESISTANT POPLARS.] Tidsskrift for Planteavl, Kobenhavn 73, (426-8). [Dan.]
In a collection of 32 European species, varieties and types, mostly belonging to Populus X berolinensis, Populus X canadensis and P. trichocarpa, which were tested in Denmark from 1961, only Populus 'Bachelieri' proved resistant to the pathogens Venturia, Marssonina and Melampsora and had at the same time such other desirable qualities as vigour of growth, large leaves, good leaf retention and resistance to wind damage.

Chira, E., and Bielikova, K. 1970. [ONE OF THE REASONS FOR THE DEVELOPMENT OF POLLEN GRAINS WITH MORE THAN THE HAPLOID CHROMOSOME NUMBER IN POPULUS ALBA.] Lesn. Cas. 16 (3/4): 233-44. [Sk.ru.e.de., 23 ref.]

Giordano, G. 1969. [SHORT NOTES ON POPLAR GROWING IN THE FAR EAST: SOUTH KOREA.] Cellulosa e Carta 20 (2): 51-8. [It.]
A short account based on a tour in Aug. 1968. The indigenous Poplars are Populus davidiana, P. glandulosa, P. koreana, P. maximowiczii and P. simonii, with a natural hybrid, P. X tomentiglandulosa (corresponding to the European P. canescens). P. nigra var. italica, P. alba and P. sicboldii have been introduced.

Hong, S. O. 1967. [HERMAPHRODITISM IN POPULUS TOMENTIGLANDULOSA T.] Res. Rep. Inst. For. Genet., Suwon No. 5, (119-22). [15 refs. [Kor.e.e.].]
Individuals of this species, thought to be a natural hybrid between P. alba and P. glandulosa, can be divided into three types: predominantly ♂, predominantly ♀, and androgynous. Drawings of flowers from these types are given.

International Union of Forest Research Organizations. 1966. [SELECTION AND BREEDING OF POPLARS, WILLOWS, AND ROBINIA IN HUNGARY.] [Proc.] Mtg. Sect. 22 Int. Union For. Res. Organ., Hungary 1966 Vol. 1, (40-57, 113-5, 120-4). [E.]

Joennoz, R., and Vallee, G. 1974. [RESEARCH AND DEVELOPMENT ON POPLAR IN THE EASTERN QUEBEC REGION. II – RESULTS OF A BREEDING PROGRAMME ON POPLARS.] Memoire, Service de la Recherche, Ministere des Terres et Forets, Quebec No. 13, 36 pp. + smries. [F.e., 16 ref.]
Discusses silvicultural advantages that could result from raising Poplar hybrids in E. Quebec, and gives preliminary results of a breeding programme between 12 species of hybrids of Poplar, in which 464 crosses were made and 57,000 plants belonging to 140 families were raised from them.

Knox, R. B., Willing, R. R., and Ashford, A. E. 1972. ROLE OF POLLEN-WALL PROTEINS AS RECOGNITION SUBSTANCES IN INTERSPECIFIC INCOMPATIBILITY IN POPLARS. Nature, UK 237 (5355): 381-383 [E., 22 ref.]
Interspecific hybrids were obtained when Populus deltoides was pollinated with a mixture of killed 'recognition' or mentor pollen of P. deltoides plus viable pollen of P. alba, whereas control pollination with P. alba pollen alone always failed to produce progeny.

Knox, R. B., Willing, R. R., and Pryor, L. D. 1972. INTERSPECIFIC HYBRIDIZATION IN POPLARS USING RECOGNITION POLLEN. Silvae Genetica 21 (3/4): 65-69 [E.de., 29 ref.]
Describes a simple method for overcoming incompatibility barriers by the use of 'recognition pollen' (killed compatible pollen rendered inviable, or pollen with reduced viability).

Kopecky, F. 1966. [THE IMPORTANCE OF ARTIFICIALLY INDUCED POPLAR AND ROBINIA POLYPLOIDS FOR THE BREEDING OF FAST GROWING TREE SPECIES.] Erdesz. Kutatas., Budapest 62 (1/3): 161-75. [41 refs. [Hu.hu.ru.g.].]
Includes for mixo- or tetraploid Populus alba, P. tremula X P. tremuloides and Robinia pseudoacacia, data on leaf morphology and stomatal frequencies, and for Robinia also growth data and data on thorniness.

Melchior, G. H., and Seitz, F. W. 1966. [SOME RESULTS OF FIELD TRIALS WITH ASPEN HYBRIDS. 1. CROSSES OF THE YEAR 1951.] Silvae Genet. 15 (4): 127-33. [1 ref. [G.g.e.].]
Plants from 7 crosses were established on 6 different sites, and results are given of mortality, growth, and stem form at 15 years on 3 of the sites.

zolin, G. P. 1970. [RESEARCH IN AND PRACTICAL UTILIZATION OF POPLAR BREEDING IN THE USSR AND ABROAD.] rud. VNII Agrolesomelior. (1), (139-86). [Ru. From abstr. in eferat. Zh. 1971 (9.56.134). Ru. NLL]

etrov, M. 1967. [CREATING PRODUCTIVE POPLAR CLONES ROM CROSSES OF POPULUS ALBA WITH P. TREMULA.] orskostop. Nauka, Sofija 4 (2): 17-27. [10 refs. [Bulg.ru.e.].]
escribes a Bulgarian hybridization programme started in 1953 hich has produced three clones whose volume increment 7 years fter planting out is up to 100%, and weight increment up to 130%, reater than that of P. X regenerata.

etrov, S. A., and Rjazanceva, P. A. 1968. ['KAZAHSTANSKIJ-72' – A NEW POPLAR CHIMAERA.] Auyl Saruasylyk ylymynyn Habarsysy (6), (78-81). [[Ru.kazakh] From abstr. in eferat. Z., Moskva (4.56.49). [Ru.] N.L.L.]
escribes this periclinal chimaera, obtained by grafting Populus achofeni on P. nigra var. italica and subsequently decapitating the raft at the point of union.

auter, R. M. 1971. CURRENT PROGRAM OF TREE IMPROVEIENT RESEARCH WITHIN THE ONTARIO DEPT. OF LANDS ND FORESTS. Pulp Paper Mag. Can. 72 (10): 101-106. [9 ref. Woodl. Sect. Index Canad. Pulp Pap. Ass. No. 2604).]

ovskij, V. M., and Sarkisova, E. G. 1969. [THE MINIMUM AGE T WHICH SELECTION OF FAST-GROWING POPLARS HOULD BEGIN.] Trudy Sredneaz. Nauc.-Issled. Inst. Lesn. Hoz. 11), (158-63). [Ru. From abstr. in Referat. Z. 1970 (6.56.192). u. N.L.L.]
bservations made for 4-5 years on the growth of seedlings of opulus nigra, P. bolleana [P. alba var. pyramidalis], and P. alba ybrids showed that selection for growth rate should be done not arlier than age 3-4 years, and that final evaluation cannot be made ntil 10-15 years.

cepot'ev, F. L., and Navalihina, N. K. 1968. [EXPERIMENTAL REATION OF POLYPLOID FORMS IN THE GENUS OPULUS.] Bjull. Mosk. Obsc. Ispyt. Prir. (Otd. Biol.) 73 (1): 15-23. [27 refs. [Ru.e.] N.L.L.]
eports the results of colchicine treatment of seed and seedlings of number of hybrids: Populus alba X P. tremula, P. tremula X P. remula, P. sukatshewi X P. tremula, and P. wesjolo-bokowenkiensis P. tremula (P. sukatshewi and P. wesjolo-bokowenkiensis are hemselves both hybrids, P. tremula X P. bolleana).

iwecki, R. 1968. OBSERVATIONS ON THE RESISTANCE OF OPLAR HYBRIDS FROM SECTION LEUCE DUBY, TO NFECTION BY VENTURIA TREMULAE ADERH. Arboretum ornickie, Poznan 13, (275-85). [4 refs. [E.pol.ru.].]
tudies were made on PK-53 (Populus tremula from Czmon X P. lba from Komik), and on 25 other selected progenies. P. tremula nd P. X canescens hybrids similar in leaf morphology to the Aspen arent are most commonly attacked, whereas P. alba and P. X anescens hybrids similar in leaf morphology to the White Poplars re more resistant.

tettler, R. F., and Bawa, K. S. 1971. EXPERIMENTAL INDUCTION OF HAPLOID PARTHENOGENESIS IN BLACK COTTONWOOD (POPULUS TRICHOCARPA T. & G. EX HOOK.). Silvae Genet. 20 (1/2): 15-25. [E., 32 ref.]

Vojtus, M. 1973. [INITIAL WORK ON THE BREEDING OF WHITE AND GREY POPLARS IN SLOVAKIA.] Lesnicky Casopis 9 (2): 113-127. [Sk.ru.e.de., 20 ref.]
n outline is given of work done since 1964 on Populus alba and P. anescens, covering the selection of elite trees and stands, comparison of methods of vegetative propagation, and the use of egetatively propagated progeny to establish clone banks and trial lots.

Vinton, L. L., and Einspahr, D. W. 1968. THE USE OF HEAT-TREATED POLLEN FOR ASPEN HAPLOID PRODUCTION. For. Sci. 14 (4): 406-7. [2 refs.]

165.43

Marcet, E. 1965. [A SPONTANEOUS BUD SPORT OF POPULUS ALBA VAR. PYRAMIDALIS.] Silvae Genet. 14 (6): 186-7. 3 refs. G.] 2 photos.

Describes and illustrates an 'auero-variegata' mutation occurring among vegetative progeny of the clone Populus alba 'Bolleana H' received from Alice Holt, and grown in Switzerland. The new variety has been named Populus alba var. pyramidalis cv. 'Goldbunt'.

17 SYSTEMATIC BOTANY

176.1

Broekhuizen, J. T. M. 1966/67. [HOW TO DISTINGUISH COMMERCIAL POPLARS.] Populier, Wageningen 3 (4): 59-61; 4 (1-4): 10-1; 26-7; 45-6; 66-7. [Du.]
Lists the distinguishing characters of the cultivars 'I-214', 'Dorskamp', 'Flevo', 'Heidemij', 'Robusta', 'Zeeland', 'Lons', 'Marilandica', 'Regenerata', 'Duitsland', 'Gelrica', 'Serotina de Champagne', 'Serotina', 'Geneva', 'Oxford' and 'Androscoggin'.

Broekhuizen, J. T. M. 1966. [THE IDENTIFICATION OF THE POPLAR CLONES GENEVA, OXFORD AND ANDROSCOGGIN.] Ned. Bosb. Tijdschr. 38 (10): 375-8. [3 refs. [Du.e.].]
Describes the three clones and gives a key, based mainly on leaf measurements.

Son, D. S., and Chung, S. B. 1970. [FIBRE LENGTH AND SPECIFIC GRAVITY OF POPULUS ALBA X GLANDULOSA HYBRID.] Res. Rep. Inst. For. Genet. Korea No. 8, (1-5). [Kor.e., 28 ref.]

18 PLANT ECOLOGY

181 MODE OF LIFE, AUTECOLOGY. SILVICULTURAL

Dzekov, S. 1965. [POPULUS ALBA IN [JUGOSLAVIAN] MACEDONIA.] God. Zborn. Zemj.-Sum. Fak. Univ. Skopje (Sum.) No. 18, 1964/1965 (5-43 + 5 tbls.). [14 refs. [Maced.g.].]
A survey covering morphology, ecology, propagation, and growth rates.

Gathy, P. 1970. [A PLEA FOR A FORGOTTEN SPECIES: THE WHITE POPLAR (POPULUS ALBA).] Bull. Soc. For. Belg. 77 (6): 265-71 + 2 plates). [F., 7 refs.]
Enumerates the advantages of this species (hardly grown now in Belgium) as a multipurpose tree, with very brief notes on its botanical and silvicultural characters and on its wood, and urges the breeding of improved strains.

181.2

Tarabrin, V. P. 1969. [THE HEAT RESISTANCE OF WOODY PLANTS, AND METHODS OF DETERMINING IT IN FIELD CONDITIONS.] Bjull. Glavn. Bot. Sada No. 74, (53-6). [Ru., 20 refs. N.L.L.]
Reviews various laboratory and field methods of determining heat resistance, and describes two techniques: (a) insertion of leafy shoots into thermos flasks containing hot water, suspended in the crown, and (b) insertion of aerial parts or roots of seedlings into tanks of hot water.

181.31

Joachim, H. F. 1972. [THE HEIGHT GROWTH OF POPLAR VARIETIES IN THE GRAUPA SET OF LYSIMETERS.] Sozialistische Forstwirtschaft 22 (3): 76-78 [De., 13 ref.]
Describes an experimental installation of concrete lysimeters in E. Germany for studying the influence of soil texture and controlled water tables.

Smith, D. W., and Gatherum, G. E. 1974. EFFECTS OF MOISTURE AND CLONE ON PHOTOSYNTHESIS AND GROWTH OF AN ASPEN-POPLAR HYBRID. Botanical Gazette 135 (4): 293-296 [E., 9 ref. OBD]
Describes a controlled-environment study conducted as a randomized, complete-block design, in which rooted cuttings of three clones of a naturally occurring hybrid (Populus grandidentata X P. alba) were subjected to five soil water potentials, ranging from -15 bars to near saturation.

181.32/.34

Alexandres, S. G. 1971. [SITE AND NUTRITION STUDIES IN POPLAR PLANTATIONS IN THE MEGALON DASOS (KOTZA-

ORMAN) FOREST ON THE R. NESTOS FLOOD-PLAIN.] Deltion Ereunon, Kentron Dasikon Ereunon Boreiou Hellados, Thessalonike No. 42, pp. 48 + 4 plates, 2 dgms. [Gr.de.e., 44 ref.]
Presents a scheme of classification of Populo-Salicetum sites on alluvial soils on the Nestos flood-plain in N. Greece, giving details for each site type of the species composition of ground vegetation and foliar N content for 10-year Populus alba.

Catrina, I., Popa, A., Constantinescu, V., and Huluta, C. 1971. [SYNERGETIC INTERACTIONS IN MINERAL NUTRITION OF HYBRID AND NATIVE POPLARS.] [Paper,] Working Group: Quantitative studies of site factors and their influence on growth of stands, IUFRO Section 21 [15th IUFRO Congress, Gainesville, Fla.] 8 pp. [F., 4 ref.]

Fritzsche, K. 1967. [RELATIONS BETWEEN SOIL MOISTURE BALANCE AND NUTRIENT SUPPLY OF POPLARS.] Arch. Forstw. 16 (6/9): 741-4. [G.]
Describes pot trials in which Populus 'Forndorf' was grown in sand or loam (a) with high dosages of NPK or (b) untreated, and the soil was watered to 30-100% of field capacity (f.c.). In both soils, growth in (a) and (b) was best at f.c.

Horie, Y. 1966. [TOLERANCE TO SALT WATER OF SEVERAL PLANTS (2).] Bull. For. Exp. Sta., Meguro, Tokyo No. 186, (113-33). [16 refs. [Jap.jap.e.e.].]
The subterranean parts of seedlings of 11 species (trees, shrubs and grasses) were soaked in salt or fresh water in August. Degree of leaf symptoms, speed of response, and mortality were higher in dune sand than in light clay.

Lavrinenko, D. D., and Volkov, F. I. 1973. [SALT RESISTANCE OF SPECIES ON THE COAST OF THE SEA OF AZOV.] Lesnoe Khozyaistvo No. 9, 33-36 [Ru.]

181.36

Dagenbach, H. 1971. [THE ROOT SYSTEMS OF SOME POPLAR VARIETIES ON DIFFERENT SITES.] Mitt. Ver. Forstl. Standortskunde ForstpflZucht. No. 20, (94-105). [De.e.]
Describes a study of the root systems of 38 trees (36 of which are illustrated by drawings made in situ), aged 9 to 23 years, of 14 cultivars growing on five sites in Baden-Wurttemberg, including a discussion of relations to performance and site.

Kitin, B. 1970. [DEVELOPMENT OF THE ROOT SYSTEM IN SOME FORMS OF POPLAR.] Nauch. Trud. Lesotekh. Inst. (Ser. Gorsko Stop.) No. 18, (83-91). [Bulg.ru.f., 9 ref.]
Describes the root systems of Populus 'Bachelierii', P. 'I-214' and P. 'Weltheimeipappel' aged 7, 8 and 10 years at three sites in Bulgaria. Few differences were observed between the three Poplars on a given site, but considerable differences were observed between the sites.

Kitin, B. 1973. [DEVELOPMENT OF THE ROOT SYSTEM IN SOME PROMISING VARIETIES OF POPLAR.] Nauchni Trudove. Vissh Lesotekhnicheski Institut, Sofiya (Gorsko Stopanstvo) 19, 73-81 [Bulg.ru.f., 5 ref.]
Describes the root systems of one tree each of Populus 'Bachelierii' and P. 'Weltheimeipappel', both 11 years old and planted at a spacing of 10X10 m on a chernozemsmo(l)nitza on alluvial meadow soils in Bulgaria.

2 SILVICULTURE

23 REGENERATION AND FORMATION OF STANDS

232 ARTIFICIAL REGENERATION

232.11

Samusev, F. F. 1970. [INTRODUCTION OF POPLARS INTO N. KAZAKHSTAN.] Trud. Vses. Nauc.-issled. Inst. Zern. Hoz. (3), (165-84). [Ru. From abstr. in Referat. Z. 1970 (9.56.111). Ru. N.L.L.]
On the basis of investigations at the Altai Botanical Garden and the Sortandy Experiment Station, the following are considered the most promising for this region: Populus alba, P. laurifolia, P. suaveolens, P. nigra, and P. tremula.

232.13

Gunzl, L. 1967. [RESULTS OF TEST PLANTINGS AND EXPERIENCES WITH POPLAR HYBRIDS.] Cbl. ges. Forstw. 84 (1): 21-35. [20 refs. [G.g.e.].]
Of various hybrids assessed at 6-10 years old on 6 Austrian test plots, the Italian clones 'I-214' and 'I-154' were best in warm sites. The Balsam Poplar hybrids, Populus 'Oxford' and P. 'Androscoggin' grew well in both warm and cool conditions, exceeding commercial Black Poplar varieties by 50-100%. The Wettstein cross P. deltoides X P. simonii also did well on some sites.

Leibundgut, H., and Brassel, P. 1971. [PERFORMANCE OF SOME POPLAR CLONES IN THE INSTRUCTIONAL FOREST OF THE ETH [SWISS TECHNICAL UNIVERSITY], ZURICH.] Schweiz. Z. Forstw. 122 (4): 185-8. [F., 1 ref.]
A note on the relative performance, by 1969, of 27 hybrid Black Poplar clones and 1 Populus alba clone planted on three sites between 1952 and 1964.

Schmid, R. 1970. [THE GROWTH OF VARIOUS POPLAR CLONES IN THE PLAIN OF ORHE [SWITZERLAND].] Schweiz. Z. Forstw. 121 (2): 117-33. [F.g.]
A study of 21 clones planted in 1950 in shelterbelts on a good Poplar site, a drained bog at 450 m.alt.

Sekawin, M. 1971. [SOME NEW POPLAR CLONES SELECTED IN ITALY.] Cellulosa e Carta 22 (5): 3-32. [It.f.e.de., 10 ref.]
Describes, illustrates and, in comparison with Populus 'I-214', gives data on the silvicultural characters, growth rate and wood quality of: four clones of P. deltoides – 'I-63/51', 'I-69/55', 'I-72/51' and 'I-77/51'; a hybrid closely related to P. deltoides – 'I-72/58'; three P. X euramericana [P. X 'canadensis'] hybrids – 'I-BL', 'I-CB2' and 'I-37/61'; and a clone of P. alba – 'I-58/57'. The fastest growing of these are 'I-63/51', 'I-77/51', 'I-72/51', 'I-72/58' and 'I-214'.

Viart, M. 1966. [THE REGIONAL POPULETUM AT ROCHY-CONDE.] Bull. Serv. Cult. Etud. Peuplier et Saule, Paris (1/2), (63-94). [F.]

232.311

Kopecky, F. 1966. TURNING INTO BEARING OF POPLAR SEEDLINGS BY GRAFTING INTO THE CROWN OF FLOWERING TREES. [Proc.] Mtg. Sect. 22 Int. Union For. Res. Organ., Hungary 1966 Vol. 1, (110-2). [E.]

232.32

Ciolac, N. 1967. [RAISING POPULUS ALBA IN THE NURSERY.] Rev. Padurilor 82 (5): 234-8 + smries.). [3 refs. [Ro.f.ru.g.e.].]

Mark, V. A. 1968. [PROPAGATION OF POPULUS ALBA.] In 'Introdukeija ta aklimatiz. roslin na Ukrajini', Resp. mizvid. zb. Vyp. 3. pp. 191-7. [[Ukr.] From abstr. in Referat. Z., Moskva (12.56.217). [Ru.] N.L.L.]
Reports trials in the Ukraine, describing a technique of propagation by seed that produced seedlings 70-100 cm. high, with root systems 40-50 cm. deep, in the first growing season.

232.323

Pospisil, J. 1968. [HYDROPONICS IN SILVICULTURE TOO?] Lesn. Prace 47 (6): 266-70. [Cz.]
Graphs and discusses data from preliminary experiments in Czechoslovakia on growing Populus alba seedlings in a hydroponic medium, using five different substrates.

232.328

Eggens, J. L. 1972. PHYSIOLOGICAL CONSIDERATIONS OF THE VEGETATIVE PROPAGATION OF POPULUS ALBA PYRAMIDALIS BUNGE. [Abstract]. Dissertation Abstracts Inter-

ational, B 32 (8): 4330. [E., Microfilm obtainable from National ibrary of Canada, Ottawa. ORS]

ggens, J. L., Hilton, R. J., and Lougheed, E. C. 1974. PHYSIO-OGICAL DISORDER OF HARDWOOD CUTTINGS OF OLLEANA POPLAR. Canadian Journal of Plant Science 54 (1): 07-114. [E.f., 7 ref. ORE]
eports on the basal necrosis of hardwood cuttings of Populus alba yramidalis. No causal pathogen was found.

ggens, J. L., Lougheed, E. C., and Hilton, R. J. 1972. ROOTING F HARDWOOD CUTTINGS OF BOLLEANA POPLAR. Canadian ournal of Plant Science 52 (4): 599-604. [E.f., 6 ref. ORE]
ardwood cuttings (consisting of the current and previous season's rowth) of Populus alba pyramidalis cv. 'Bolleana' were taken at onthly intervals from Sept. to May in 1967-68 and 1968-69 in ntario.

uang, T.-S. 1965. [A PRELIMINARY INVESTIGATION ON AISING PLANTING STOCK BY WATER-SOAKING CUTTINGS O STIMULATE ROOT FORMATION.] Sci. Silvae, Peking 10 (1): 3-75. [Chin.] N.L.L.

yun, S. K., and Hong, S. O. 1968. FUNDAMENTAL MECH-NISM OF ROOT FORMATION IN THE CUTTINGS OF FOREST REES. Res. Rep. Inst. For. Genet., Suwon No. 6, (1-52). [90 refs. E.e.kor.].]
study of the physiological and biochemical factors responsible for ie variable rooting capacity of cuttings from different trees of a ven species, carried out on individual Pinus rigida and Populus alba ees that had been selected as being easy and difficult to root (on ie basis of repeated propagation tests).

tituto di Coltivazioni. 1966. [PROCEEDINGS OF THE CON-ERENCE ON THE PROPAGATION OF WOODY SPECIES: 26-28 OV. 1964.] Istituto di Coltivazioni Arborea, Universita di Pisa. pp. 89. [Many refs. [It.it.e.e.] Price Lire 10,000. E.M.B.]

nson, L. 1974. [EFFECTIVENESS OF PROPAGATION OF YBRID ASPEN AND GREY POPLAR BY ROOT CUTTINGS, IN ELATION TO THE CONDITIONS IN WHICH THE PARENT LANTS WERE GROWN.] Sylwan 118 (2): 46-51. [Pol.ru.e., 5 f.]
oot cuttings were taken from Populus tremula X P. alba var. nivea lone 55/8) and from P. tremula X P. tremuloides (clone 264 (2/2)) ants grown under six different mineral fertilizer schedules and at rious spacings.

achim, H. F. and Zoffel, G. 1965. [RAISING PLANTS OF THE ALSAM POPLAR CULTIVAR 'ANDROSCOGGIN'.] Sozial. orstw., Berl. 15 (3): 87-8. 3 refs. [G.]
ot and nursery trials on different soils indicated that heavy soils, rticularly a sandy clay with a fluctuating water regime, were nsuitable, and that results in terms of speed of flushing, rooting, owth, and survival were better when the topmost bud was left covered than when it was covered with soil.

alik, S., Shah, S. I. H., and Akram, M. 1972. [STUDIES IN OOT-PROMOTING SUBSTANCES. (1). ROOTING ACTIVITY F POPLAR STEM CUTTINGS.] Pakistan J. Sci. Ind. Res. 15 (3): 91-192. [E., 13 ref.] From Abstract Bulletin of the Institute of aper Chemistry 44, 7380. LTP.
ethanol extracts of Populus alba stem cuttings were fractionated y descending paper chromatography, and the root-initiating and ot-promoting activity of the substances isolated were ascertained y the mung-bean bioassay technique.

hmid, A. 1972. [ROOTING OF CUTTINGS OF LOCAL [SWISS] ARDWOODS WITH SPECIAL REFERENCE TO THE ROOTING EHAVIOUR OF POPULUS TREMULA.] Berichte der Schweizer-chen Botanischen Gesellschaft 82 (1). [De., review in Schwei-rische Zeitschrift fur Forstwesen 123, 720. De.]

hmid, A., and Meier, H. 1971. [THE EFFECT OF ABSCISIC CID ON ROOT FORMATION IN THE VEGETATIVE PROPA-ATION OF POPULUS ALBA.] Verhandlungen der Schweizer-chen Naturforschenden Gesellschaft 77-78. [F.] From Berichte ochemie und Biologie (1974) 392, 1696. De. Reinbek.
bscisic acid stimulated root growth on cuttings bearing buds, but ot on disbudded cuttings.

Zufa, L., Day, R. J., and Miller, J. S. 1970. THE ROOTABILITY OF ADVENTITIOUS SHOOTS FROM ROOT SEGMENTS OF THE SECTION LEUCE, GENUS POPULUS. Extr. from Rep. Res. For. Bot. Glendon Hall Fac. For. Univ. Toronto 1969/70, (6).
Root segments of 20 Aspen hybrid clones were planted as a source of young suckers for stem-cutting propagation.

233 AFFORESTATION

Costin, E. 1964. [ECOLOGICAL CONDITIONS OF FOREST CROPS ON LITTORAL SANDS OF THE DANUBE DELTA.] Institutul de Cercetari Forestiere, Bucharest. pp. 154 + 2 gphs. 82 refs. [Ro.ru.e.]
Describes in detail the soil and climate, with particular reference to soil water regime.

Kluczynski, B. 1974. [INVESTIGATION ON THE GROWTH AND DEVELOPMENT OF SEEDLINGS OF SOME SPECIES OF TREES AND SHRUBS ON TWO TYPES OF POWER-STATION ASH.] Folia Forestalia Polonica, A. No. 21, 79-104. [Pol.ru.e., 8 ref.]
Describes trials in which seeds of 18 species of trees and shrubs were sown in pots containing two types of power-station ash obtained from the burning of lignite and coal.

Kohlstock, N., and Weber, P. 1969. [EXPERIENCE IN AND RESULTS OF AFFORESTATION OF GRAVEL-PIT SPOIL MOUNDS.] Arch. Forstw. 18 (9/10): 1001-6. [G., 3 refs.]
An account of the measures used to establish Populus 'Androscoggin' [cf. F.A. 31 No. 2481] and Pinus sylvestris on levelled spoils in E. Germany.

Kohlstock, N., and Weber, P. 1969. [USE OF POPLAR SETTS FOR AFFORESTATION OF GRAVEL PITS.] Sozial. Forstw., Berl. 19 (8): 232-3. [G.]
Describes a technique for establishing Populus 'Androscoggin' from setts planted direct, with a hand dibble and firming spike, and the subsequent pruning schedule.

Morawski, S. 1968. [AFFORESTATION OF COAL TIPS.] Sylwan 112 (4): 59-64 + 3 tbls. [6 refs. [Pol.ru.e.].]
Gives details of afforestation trials on 3 burned and 3 unburned tips in Poland, where planting was done in the period 1955-61.

Trescevskij, I. V. 1966. [AFFORESTATION IN THE RIVER FLOOD-PLAINS OF DROUGHTY REGIONS IN THE VOLGA-DON BASIN.] Lesn. Hoz. 19 (7): 40-5. [Ru.]
A table classifies the soils into six basic groups, subdivided into six flood-types according to degree of flooding (prolonged, short-term or occasional), and recommends species wherever possible for each class.

Zak, J. M., and Wagner, J. 1967. OIL-BASE MULCHES AND TERRACES AS AIDS TO TREE AND SHRUB ESTABLISHMENT ON COASTAL SAND DUNES. J. Soil Wat. Conserv. 22 (5): 198-201. [3 refs.]

237 AMELIORATION OF FOREST SITES

Heinsdorf, D., and Krauss, H. H. 1970. [RESULTS OF FERTILIZER TRIALS WITH 'ANDROSCOGGIN' POPLARS ON A FAIRLY POOR SANDY SOIL IN THE POTSDAM DISTRICT.] Arch. Forstw. 19 (5): 555-81. [G.ru.e., 9 refs.]
Populus 'Androscoggin' was planted (as 2-year plants) on a well drained site ploughed to a depth of 60 cm. Fertilizer applications were made in the second, third and fourth years, either in a trial of 12 combinations of nutrients, or in a balanced dose given at different times during the growing season.

238 TIMBER PLANTATION CROPS REQUIRING SPECIAL TREATMENT

Popescu, G., and Diaconescu, S. 1970. [SITE CONDITIONS AND TECHNIQUES FOR ESTABLISHING SPECIAL PLANTATIONS FOR PULPWOOD PRODUCTION FROM SOME HARDWOOD SPECIES.] Rev. Padurilor 85 (6): 304-8 + smries. [Ro.g.e.f.ru.]
Deals with the establishment and economics of pulpwood plantations of Populus X 'canadensis', P. alba and Salix spp. in Rumania.

26 COMBINATIONS OF FORESTRY WITH AGRICULTURE

263 IRRIGATED FORESTS

Boxsem, W. 1972. [WINDBREAK INVESTIGATION IN THE NORTHERN PART OF NORTH HOLLAND.] Nederlands Bosbouw Tijdschrift 44 (5): 109-119. [Nl., 12 ref.]
Evaluates the condition of various windbreaks, the oldest established in 1937-38 and the others in 1957-62. Details are given of the performance of the 15 tree and shrub species used.

Marinov, M., Naumov, Z., et al. 1970. [SILVICULTURAL FEATURES OF DANUBE FLOOD-PLAIN SITES.] Gorskostop. Nauka 7 (1): 17-37. [Bulg.ru.f., 19 refs.]
Describes the soil types, soil moisture regime, and duration of flooding of the Danube flood-plain in Bulgaria, and on this basis constructs a scheme of site classification.

265 STRIPS OR LINES AT ROAD, RAIL AND CANAL SIDES, ETC., HEDGEROW TREES

Berdyklycev, K. 1968. [THE IMPORTANCE OF WOODY SPECIES FOR DRAINAGE IN THE CONDITIONS OF N. TURKMENIA.] Izdatelstvo 'Ylym', Ashkhabad. pp. 100. [Ru., 158 refs. N.L.L.]
Describes the importance of tree species for 'biological drainage' in the cotton-growing areas near Tashauz on the lower reaches of the Amu-Darya.

Tagirov, A. P., and Dosahmetov, A. O. 1970. [THE EFFECT OF STANDS ALONG IRRIGATION CANALS ON THE GROUND -WATER LEVEL IN THE GOLODNAJA STEPPE.] Lesn. Hoz. (7), (25-6). [Ru.]
Observations were made of the seasonal changes in ground-water level in stands of Acer negundo and Populus alba var. pyramidalis (both 25 years old), and of Robinia pseudoacacia (9 years old) at various distances from an irrigation canal in Uzbekistan.

268 PASTURED FORESTS. GRAZING ON FOREST AND OPEN RANGES

Pearson, H. A. 1968. THINNING, CLEARCUTTING, AND RESEEDING [WITH FORAGE SPECIES] AFFECT DEER AND ELK USE OF PONDEROSA PINE FORESTS IN ARIZONA. U.S. For. Serv. Res. Note Rocky Mt. For. Range Exp. Sta. No. RM-120, pp. 4. [8 refs.]
Logging or slash disposal after thinning may decrease deer but increase elk populations. Deer and elk did not significantly affect forage utilization by cattle.

4 FOREST INJURIES AND PROTECTION

42 INJURIES FROM INORGANIC AGENCIES (EXCLUDING FIRES)

424 SOIL CONDITIONS; EROSION EFFECTS

Courtois, J. E., et al. 1966. [A STUDY OF CHLOROTIC SYMPTOMS OF VARIOUS POPLARS IN ARID AREAS OF TURKEY.] C. R. Acad. Sci., Paris 262D (14): 1538-41. [4 refs. [F.f.] O.R.S.]
Chlorotic symptoms of Populus nigra and P. alba were associated with an increase in mineral and organic P and in phytic acid (hexaphosphoric inositol) in the leaves. The increase in phytic acid appeared to cause a deficiency in Fe available to the enzymes synthesizing chlorophyll.

Courtois, J. E., et al. 1967. [CHLOROSIS IN VARIOUS POPLARS AND PLATANUS ORIENTALIS.] Bull. Serv. Cult. Etud. Peuplier et Saule, Paris (1/2), (1-27). [39 refs. [F.f.]
Includes a description of symptoms and leaf analyses in Turkish Populus nigra and P. alba and in a partly healthy, partly chlorotic Platanus orientalis, and some results of treatments of P. nigra with Endofer, an Fe-Na salt of ethylene diamide tetracetic acid combined with urea.

Mahno, G. F. 1969. [WINTER MORTALITY OF IRRIGATED FOREST PLANTATIONS ON THE SALINE LANDS OF THE KHOREZM OASIS [SOVIET CENTRAL ASIA].] Lesn. Hoz. 22 (11): 24-9. [Ru.]
Gives details of survival of plantations of Robinia pseudoacacia, Ulmus pumila var. arborea, Populus bolleana [P. alba var. pyramidalis], P. nigra, and Fraxinus pennsylvanica on furrow-irrigated and flood-irrigated plots.

425 CHEMICAL INFLUENCES (ATMOSPHERIC)

Dassler, H. G., Kastner, W., and Ranft, H. 1968. [SILVICULTURAL AND YIELD STUDIES IN A SPECIES TRIAL EXPOSED TO ACUTE POLLUTION FROM A ZINC SMELTER NEAR FREIBERG [SAXONY].] Arch. Forstw. 17 (2): 145-58. [11 refs. [G.g.ru.e.].]

44 DAMAGE BY HARMFUL PLANTS. VIRUS DISEASES

442 PARASITIC (HIGHER) PLANTS. CLIMBERS AND EPIPHYTES

Marinovic, Z. 1964. [THE COLONIZATION OF TREES BY THE LICHEN XANTHORIA PARIETINA ON THE DELIBLATO SANDS.] Sumarstvo 17 (5/7): 205-9. 11 refs. [Serb.g.]
Presents data from a survey in 1960-62 showing the % of stems of ca. 20 species colonized, and the mean % of the stem covered.

443 FUNGI AND BACTERIA

Chaudhry, G. U., et al. 1969. A SPECIAL REPORT FOR 1968. INSECT PESTS AND DISEASES OF POPLARS IN WEST PAKISTAN. Forest Research Institute, Peshawar. pp. 41. [18 refs.]
Presents preliminary results of a survey of diseases and insect pests of indigenous (Populus alba, P. ciliata and P. euphratica) and introduced (P. X euramericana and P. nigra) Poplars in West Pakistan.

443.3

Anonymous. 1967. DISEASES OF POPLARS. Extr. from Rep. For. Timb. Bur. Aust. 1966, (28).
Investigation of an epidemic attack of Cytospora chrysosperma on Poplars in the Australian Capital Territory and New South Wales showed that infection occurred only on the N. (sunny) side of the stem in a vertical strip 10-15 cm. wide. The species affected were Populus alba, P. deltoides, P. yunnanensis and some hybrid forms.

Canova, P. 1967. [BIOLOGY OF MELAMPSORA PINITORQUA.] Gorskostop. Nauka, Sofija 4 (3): 67-79. [14 refs. [Bulg.ru.e.].
Reviews the literature on M. pinitorqua, and describes investigations in Bulgaria on the susceptibility to it of young plants of Pinus sylvestris, P. nigra, Populus tremula (forms with grey-white and grey-green bark), P. tremula X P. tremula, P. alba X P. alba, and P. alba X P. tacamahaca.

Chang, K. Y., and Yong, J. L. 1970. [RELATIVE POLAR CANKER DISEASED BY CYTOSPORA SP. RESISTANCE OF NATIVE AND INTRODUCED POPLAR CLONES.] Res. Rep. Forest Res. Inst. [Korea] No. 17, 61-64 [Kor., 11 ref.] From Korean Scientific Abstracts (1971) 71/84. APB.
Describes inoculation tests on 42 clones in Korea. Populus 'I-214', and P. nigra X P. maximowiczii were the most resistant to Cytospora, and P. alba and P. simonii the most susceptible.

Dochinger, L. S. 1967. OCCURRENCE OF POPLAR CANKERS CAUSED BY FUSARIUM SOLANI IN IOWA. Plant Dis. Reptr. 51 (11): 900-3. [12 refs. I.M.I.]
Cankers of Populus deltoides and hybrids between P. grandidentata and P. alba were found to be caused by F. solani; this is the first record of the fungus on these species in Iowa.

Dochinger, L. S. 1969. AGROBACTERIUM GALL OF HYBRID POPLAR TREES IN IOWA. Abstr. in Phytopathology 59 (8): 1024.
An Agrobacterium sp. was consistently isolated from young cankers in three natural Populus alba X P. grandidentata hybrid stands.

ischetti, D. L., et al. 1965. [POPLAR CANKER IN THE ROVINCE OF MENDOZA, CAUSED BY SEPTORIA MUSIVA.] lia No. 206, (1-8). 15 refs. [Span.] C.G.B.
ives information on symptoms, pathogenicity tests, distribution id hosts in this region of Argentina.

e, G. P. [Ke, K. P.,] et al. 1964. [OBSERVATIONS ON THE EVELOPMENT AND MORPHOLOGY OF MELAMPSORA OSTRUPII WAGNER ON POPULUS TOMENTOSA.] Sci. Silvae, king 9 (3): 221-32. 6 refs. [Chin.chin.e.] N.L.L.
escribes M. rostrupii (a first record in China), including details of ie uredinia, telia, and the corresponding spores, with an account of ie damage caused to leaves and stems of young P. tomentosa. No ternate host was found.

ansbrough, J. R. 1967. BACTERIAL CANKER OF POPLAR IN ORTH AMERICA. Proc. 14th Congr. Int. Union For. Res. Organ., unich 1967 Pt. V, Sect. 24, (427). [E.]
1965, previously undescribed cankers were found in Ohio on opulus alba and P. tremuloides. Similar cankers were later observed n natural hybrids of P. alba X P. grandidentata.

ock, W. K., and Dochinger, L. S. 1971. CHEMOTHERAPEUTIC ONTROL OF STEM CROWN GALL OF SHERILL HYBRID OPLAR TREES. Abstr. in Phytopathology 61 (2): 129.
rown gall on stems of Sherrill Poplar (Populus grandidentata X P. ba) cuttings was partially controlled by a coordination product of ,4-xylenol and meta-cresol (Bacticin) applied topically to eoplasms.

gmandy, Z., and Pagony, H. 1965. [A DANGEROUS HEART-ROT UNGUS OF POPULUS ALBA AND P. CANESCENS.] Erdo 4 (1): 19-25. 7 refs. [Hu.ru.g.]
ttention has been called to damage to P. alba in Czechoslovakia, used by a species of Phellinus as yet unidentified. This fungus ccurs also in Hungary, particularly on dry sites.

enkins, A. E. 1967. SPECIMEN RECORD OF POPLAR SPOTTED NTHRACNOSE (SPHACELOMA) IN OKLAHOMA. Plant Dis. eptr. 51 (9): 785. [1 photo.]
herbarium specimen, labelled Phyllosticta brunnea, on Populus ngustifolia and some other herbarium specimens examined later, ppear to be S.populi; P.angustifolia is a new suspect, and this is the rst N. American record of the pathogen.

Jlingner, A. E. 1969. [POPULUS ALBA CV. 'ROUMI', A NEW OST FOR SEPTORIA MUSIVA.] Revista de la Facultad de iencias Agrarias, Universidad Nacional de Cuyo, Mendoza 15 (2): 85-94. [Es.e., 8 ref. NLL]
xperimental inoculations proved that P. alba cv. 'Roumi' is usceptible to infection by S. musiva (a first record), but that the anker is completely healed 3 years after infection, and has little ffect on the value of the timber.

lagnani, G. 1964. [LESIONS ON POPLAR LEAVES CAUSED BY IARSSONINA SPP.] Pubbl. Cent. Sper. Agric. For., Roma 7, 251-83 + 6 plates). 31 refs. [It.it.e.e.]
detailed account of symptoms, isolation and culture of fungi and e-inoculation of the hosts. M. castagnei is strongly parasitic on opulus alba and weakly parasitic on P. X euramericana clones. M. opuli-nigrae is moderately parasitic on P. nigra.

lagnani, G. 1966. [INVESTIGATIONS ON THE POSSIBILITY OF HYSIOLOGICAL SPECIALIZATION IN MELAMPSORA ALLII POPULINA.] Pubbl. Cent. Sper. Agric. For., Roma 8, (127-33). [2 efs. [It.it.e.e.].]
abulates data on results of inoculation experiments on Populus lba, P. deltoides, P. nigra, P. yunnanensis and P. 'I-154' (all known o show different degrees of susceptibility to M. allii-populina under atural conditions) with infected material collected on plants of P. euramericana from four widely separated localities.

lagnani, G. 1966. [TESTS OF THE RESISTANCE OF SOME OPLAR CLONES TO DOTHICHIZA POPULEA. II.] Pubbl. Cent. per. Agric. For., Roma 8, (249-58 + 1 plate). [6 refs. [It.it.e.e.].]
ests in central Italy on Populus alba and four more clones (P. X uramericana cvs. 'I-476', 'I-488' and '45/51', and P. deltoides cv. 55/51') showed that '45/51' was moderately resistant and '65/51', ke P. alba, highly susceptible. 'I-476' and 'I-488' were moderately usceptible.

Magnani, G. 1968. [DAMAGE BY PHOMA URENS ELL. ET EV. ON NURSERY-GROWN POPLARS.] Pubbl. Cent. Sper. Agric. For., Roma 10 (1): 1-10 + 4 plates. [5 refs. [It.it.e.e.].]
In Jan. 1966, rooted cuttings of some clones of Populus nigra in an Italian nursery were found to be attacked by P. urens. Observations indicated that whereas some clones were susceptible, others and some other species (P. alba, P. deltoides, and P. X euramericana) were resistant.

Magnani, G. 1973. [INJURIES CAUSED BY FUSARIUM SPOROTRICHOIDES ON POPLAR STEMS.] Pubblicazioni del Centro di Sperimentazione Agricola e Forestale 12, 235-244 + 3 pl. [It.e., 10 ref.]
Large patches of dead bark tissue attributable to attack by F. sporotrichoides were observed on Poplars growing on a poor site near Rome in March 1971.

Quraishi, M. A., and Jamal, S. M. 1971. [FUNGAL ENEMIES OF POPULUS ALBA LINN. IN WEST PAKISTAN.] Pakistan J. For. 21 (2): 155-7. [5 ref.]
A note briefly describing the distribution and botanical characteristics of P. alba and recording Melampsora aecidioides as the cause of a leaf rust and Pleurotus ostreatus as that of a stem rot.

Stahl, W. 1967. AN INVESTIGATION ON THE CYTOSPORA DISEASE OF POPLARS IN AUSTRALIA. Proc. 14th Congr. Int. Union For. Res. Organ., Munich 1967 Pt. V, Sect. 24, (428-44). [8 refs. [E.e.].]
Describes an outbreak of Cytospora chryosperma on Poplars (Populus alba, P. deltoides, P. yunnanensis and some hybrids) near Canberra and in New South Wales in 1965.

Weisgerber, H. 1968/69. [THE IMPORTANCE OF SHOOT BLIGHT [CAUSED BY POLLACCIA RADIOSA] FOR POPLARS OF THE SECTION LEUCE. II. SUSCEPTIBILITY OF HOSTS ON DIFFERENT SITES. III. METHODS AND RESULTS OF INFECTION TESTS AND EARLY-TESTING STUDIES.] Holzzucht, Reinbek 22 (4): 38-43; 23 (2): 21-3. [17 refs. [G.g.e.].]

45 DAMAGE BY ANIMALS

453 INSECTS

Frankenhuyzen, A. van. 1968. [THE BIOLOGY OF PARALEUCOPTERA SINUELLA, A POPLAR LEAF MINER.] Populier, Wageningen 5 (3): 40-2. [Du.du.]
Describes the various stages and gives details of the timing of development during outbreaks (locally severe) in the Netherlands in 1966-67 on Populus alba, P. tremula, P. candicans and P. 'Serotina'.

Hochmut, R. 1966. [ROOT APHIDS IN NURSERIES.] Lesn. Prace 45 (11): 510-1 + 1 plate. [Cz.]
Gives notes on the morphology and bionomics of Pachypappa vesicalis and Stagona xylostei, which migrate in late spring to roots of Norway Spruce transplants from the leaves of their primary hosts (Populus alba and Lonicera spp. respectively).

Ioannisiani, T. G., Birg, A. V., and Lavrova, N. K. 1970. [DATA ON THE BIOLOGY OF WEEVILS OF THE GENUS PHYLLOBIUS (COLLEOPTERA, CURCULIONIDAE).] Zool. Z. 49 (3): 384-9. [Ru.e., 12 refs. B.A.P.]
Studies in the Brest region in 1963-64 showed that development of larvae and imagos of P. maculicornis, P. arborator, and P. argentatus takes place in Birch stands of various types.

Khalanskaya (Halanskaja), L. P. 1968. PESTS OF POPLAR. Zascita Rastenij, Moskva 13 (5): 47. [Ru., From abstr. in Rev. appl. Ent. 1970 58 (11), (No. 3343).]

Kusevska, M. 1972. [THE INFLUENCE OF ECOLOGICAL CONDITIONS ON THE OCCURRENCE AND DEVELOPMENT OF POLYHEDROSIS IN LARVAE OF STILPNOTIA SALICIS.] Fragmenta Balcanica 9 (2): 9-19. [Ma.e., 6 ref.] From Review of Applied Entomology, A 63, 1032.
Laboratory studies were made in Yugoslavia on the development of a virus disease in larvae of S. (Leucoma) salicis reared on different Populus spp. or under different temperature regimes.

Miklos, I. 1971. [FOOD QUALITY AS ONE OF THE CAUSES OF OUTBREAKS OF PYGAERA ANASTOMOSIS IN PLANTATIONS OF HYBRID BLACK POPLARS.] Sum. List 95 (3/4): 53-83.

[Sh.e., 36 ref. Another version in Topola 1971 (83/85), (55-60). Sh.e., 12 ref.]
The larvae fed on P. 'Regenerata' had fewer instars, of shorter duration, and showed lower mortality, higher fecundity, and higher reproductive potential than those fed on the other Poplars.

Morris, O. N. 1969. SUSCEPTIBILITY OF SEVERAL FOREST INSECTS OF BRITISH COLUMBIA TO COMMERCIALLY PRODUCED BACILLUS THURINGIENSIS. II. LABORATORY AND FIELD PATHOGENICITY TESTS. J. Invert. Path., New York 13 (2): 285-95. [14 refs.]
Of species newly tested in the laboratory, Rhyacioni buoliana, Hyphantria cunea, Epinotia tsugana, Gracillaria invariabilis, Archips rosana and Vanessa cardui were highly susceptible to several preparations in high concentrations, the pathogenicity of the 12 preparations tested varying greatly with species.

Templin, I. 1971. [OCCURRENCE OF GYPSONOMA ACERIANA.] Sozial. Forstw. 21 (1): 24-5. [G.]
Briefly discusses bionomics, hosts, and control in E. Germany, where Balsam Poplars, Black Poplar hybrids, Populus nigra, P. alba and P. canescens are attacked, but not P. tremula.

Varga, F. 1968. [NUTRITION STUDIES ON LYMANTRIA DISPAR.] Erdesz. Faipari Egyetem tud. Kozl., Sopron (1), (129-41). [Hu.ru.g.e.]

48 INJURIES DUE TO UNKNOWN OR COMPLEX CAUSES

Bortoluzzi, O. 1969. [SAVING THE PINE WOODS OF RAVENNA.] Monti e Boschi 20 (5): 33-41. [It.it.e.]

Canova, P. 1968. [BROWN SLIME FLUX ON SOME POPLAR CLONES.] Gorsko Stopanstvo 24 (10): 38-42. [Bulg.]
A study was made on six clones ('Bachelieri', 'Canadensis B 12, 'Vernirubens', 'I-214', 'Regenerata 276', and 'Weltheimeipappel') at various spacings on several different sites in Bulgaria.

Kalandra, A., and Urosevic, B. 1965. A NEW DISEASE OF POPLARS. Lesn. Cas., Praha 11 (6): 541-8. [Cz.E.cz.e.ru.g.f.]
Describes the symptoms and nature of attack on shoots of a wilt disease apparently confined to Populus angulata and to P. angulata X P. nigra, as observed in two experimental nurseries in N. Bohemia.

5 FOREST MENSURATION

52 MEASUREMENTS OF STEM DIMENSIONS AND VOLUME OF TREES, STANDS, FORESTS AND TIMBER

Avanzo, E., and Ghisi, G. 1968. [MENSURATIONAL DATA AND PHYSICAL AND MECHANICAL PROPERTIES OF WOOD OF POPULUS ALBA FROM CASENTINO.] Pubbl. Cent. Sper. Agric. For., Roma 10 (2): 111-22 + 1 plate. [7 refs. [It.it.e.e.].]
Presents data, from a 36-year-old plantation, on tree b.a., height, and volume, and on density, and compression, bending, and impact strength of the wood.

523 BARK (INCLUDING BARK INCREMENT)

Sopp, L. 1965. [THE BARK PERCENT OF POPLARS.] Erdo 14 (2): 66-70. 8 refs. [Hu.hu.ru.g.]
Since 1954, eighteen volume tables have been produced, but these are for gross volumes over bark. Bark %, as the factor having the greatest influence on net volume, has now been studied in individual species and hybrids.

525 VOLUME BY ASSORTMENTS. MERCHANTABLE VOLUME

Karlin, V. R. 1971. [VOLUME AND ASSORTMENT TABLES FOR STANDS OF POPULUS ALBA.] Lesnoi Zhurnal 14 (6): 40-43 [Ru., 4 ref.]
Gives tables of volumes and assortments for stems of d.b.h. 8-68 cm (and three different height categories). The tables are based on measurement of 436 stems felled in the upper Don region (south-central Russia).

56 INCREMENT; DEVELOPMENT AND STRUCTURE OF STANDS

Armasescu, S., and Tanasescu, S. 1964. [COMPARATIVE MEASUREMENTS IN STANDS OF POPULUS X EURAMERICANA AND NATIVE WHITE AND BLACK POPLARS [IN THE DANUBE FLOODPLAIN].] Rev. Padurilor 79 (10): 545-52. 11 refs. [Rum.]
Presents data, from 8 sites, on stand structure, mean diam., mean height, yield class, volume/ha., and assortments, for the three species, which show that, on the most favourable sites, the native Poplars can attain at 20 years a growing stock of 280-440 cu.m./ha. and a c.a.i. of 14-22 cu.m./ha., or 80-95% of the values for the introduced hybrids. On less favorable sites the native species are superior to the introduced.

Tomov, K. 1965. [GROWTH AND PRODUCTIVITY OF POPULUS 'BACHELIERII'.] Gorsko Stopanstvo 21 (5): 26-30. [Bulg.]
Tabulates data on growth up to age 10 years on alluvial meadow sites in Bulgaria.

561 INCREMENT IN HEIGHT, DIAMETER, BASAL AREA, FORM AND QUALITY

Halupa, Z. 1967. [THE COURSE OF GROWTH OF OAK ON SZIK SOILS.] Erdesz. Kutatas., Budapest 63 (1/3): 95-108. [9 refs. [Hu.hu.ru.g.].]
Comparative growth curves for the periods July and September in relation to temperature and moisture are presented for Q. robur, Fraxinus excelsior, F. americana, Populus alba and Ulmus campestris from a mixed stand.

566 YIELD TABLES AND THEIR CONSTRUCTION

Armasescu, S. 1970. [FRESH DATA ON THE ACTUAL AND POTENTIAL YIELD OF INDIGENOUS BLACK AND WHITE POPLAR STANDS IN RUMANIA.] Rev. Padurilor 85 (8): 397-401 + smries.). [Rum.f.e.g.ru., 3 refs.]
The first Rumanian yield tables for these species have been constructed from measurements of 81 sample plots of Populus alba and 58 of P. nigra.

Palotas, F., and Szodfridt, I. 1971. [THE YIELD OF STANDS OF POPULUS ALBA AND P. CANESCENS.] Erdeszeti Kutatasok 67 (2): 185-194 + 1 tab. [De., 13 ref.]
Presents a provisional yield table for the two species combined, on the basis of 99 temporary plot surveys in Hungary, and discusses their silvicultural characteristics and potential (mainly in forest protection and game management).

58 SURVEYING AND MAPPING. AERIAL SURVEY

Harin, N. G., Bogojavlenskaja, R. A., and Kolovskij, R. A. 1965. [PHYTOPATHOLOGY, SPECTROPHOTOMETRY AND AERIAL PHOTOGRAPHY.] Nauc. Dokl. Vyss. Skoly (Biol. Nauki) (3), (111-7). 14 refs. [Ru.] N.L.L.
Laboratory and field investigations were made of the effect of pathological factors on the spectral brightness of plant leaves in connexion with the use of aerial photography to determine damage by fungi, insects and fires.

6 FOREST MANAGEMENT

61 FOREST MANAGEMENT: GENERAL, THEORY AND PRINCIPLES

Karlin, V. R. 1970. [THE AGE OF MATURITY OF POPULUS ALBA STANDS IN THE MIDDLE DON FLOODPLAIN.] Lesn. Z. 13 (1): 81-3. [Ru., 2 refs.]
Gives details of volume and increment for ages 15, 20 . . . 60 years. The rotation of maximum volume production is 30-35 years; the technical rotation is 40-45 years.

8 FOREST PRODUCTS AND THEIR UTILIZATION

81 WOOD AND BARK: STRUCTURE AND PROPERTIES

811.1

Stieber, J. 1967. [SOME METHODOLOGICAL PROBLEMS OF QUANTITATIVE WOOD ANATOMY.] Botanikai Kozlemenyek, Budapest 54 (3): 123-8. [5 refs. [Hu.] N.L.L.]
Discusses numerical relationships of various cell parameters in relation to annual rings, sp. gr., etc., and variations between related taxa, on the basis of a study of Populus X marilandica and P. alba wood.

811.2

Kennedy, R. W., and Farrar, J. L. 1965. INDUCTION OF TENSION WOOD WITH THE ANTI-AUXIN 2,3,5-TRI-IODOBENZOIC ACID. Nature, Lond. 208 (5008): 406-7. 7 refs.

812 PHYSICAL AND MECHANICAL PROPERTIES

Mutibaric, J., and Cemerikic, M. 1971. [THE STRUCTURE AND PHYSICAL AND MECHANICAL PROPERTIES OF THE WOOD OF NATIVE [YUGOSLAVIAN] SPECIES OF POPLAR AND WILLOW.] Topola (86/87), (3-48). [Sh.e., 36 ref.]
Gives data on fibre dimensions and physical and mechanical properties of Populus alba, P. nigra, P. canescens, P. tremula, and Salix alba.

Stojanov, V., and Encev, E. 1964. [PHYSICAL AND MECHANICAL PROPERTIES OF THE WOOD OF HYBRID POPLARS GROWN ON RIVERSIDE SITES.] Gorskostop. Nauka, Sofija 1 (6): 57-64. 4 refs. [Bulg.ru.g.]
Compares the growth rates and wood properties of Populus 'Bachelieri', P. X 'canadensis' hybrids 81/31 B12 and 81/30 B6, P. X marilandica, P. rasumowskyana X P. laurifolia 200/32, B80, and P. rasumowskyana X P. 'canadensis' hybrid 252.

Tabatabai, M., Terver, P., and Boulanger, M. 1968. [PRELIMINARY STUDY OF THE WOOD OF POPULUS ALBA CVS. 'BOUMI' AND 'SHIRAZI' FROM THE ISFAHAN REGION.] Bulletin, Faculty of Forestry, University of Teheran, Karadj No. 10, p. 45. [Pe.f. From abstr. in Rapport, Faculte des Forets et Paturages, Universite de Teheran 1969 Vol. 2, (89-90). F.]

812.2

Dumitrescu, N. S., Marinescu, I., et al. 1969. [DETERMINATION OF THE INFLUENCE OF DIFFERENT FACTORS ON SORPTION AND DESORPTION HYSTERESIS IN THE WOOD OF DIFFERENT SPECIES.] Industr. Lemn. 20 (10): 361-8 + smries. [Rum.f.e.ru.g., 12 refs.]
Green or oven-dry specimens of Lime, Beech, White Poplar, Walnut, and Spruce, of various sizes and cross-sections, were held at 65% relative humidity and 20° C. for 20 days. Sorption and desorption curves are presented.

813 WOOD CHEMISTRY

Markovic, N., Terzan, N., and Pjevic, V. 1966. [THE CHEMICAL COMPOSITION OF WOOD OF VARIOUS SPECIES.] Sumarstvo 19 (1/2): 17-26. [6 refs. [Serb.ru.].]
Gives figures showing %s of various components (cellulose, pentosans, lignin, extractives, etc.) in wood and bark of Salix alba, Populus alba, Ulmus effusa, Pinus nigra var. gotschensis and Picea omorika, and discusses their distribution through the stem.

813.1

Mathes, M. C., Einspahr, D. W., and Winton, L. L. 1970. CHEMICAL COMPOSITION OF CALLUS TISSUE AND JUVENILE STEMS FROM ASPEN SPECIES. Genet. Physiol. Note Inst. Paper Chem. No. 8, pp. 9 [13 refs.]
Chemical analyses of (a) callus tissue isolated from Populus canescens, P. alba, P. grandidentata, P. tremuloides and P. tremula var. davidiana, and (b) juvenile stem tissue of P. canescens, were compared with analyses, previously reported by Kremers in 1964 of xylem cells of P. tremuloides during 5 stages of differentiation in trees.

815 EFFECT OF GROWTH FACTORS ON STRUCTURE AND PROPERTIES

Watanabe, H. 1967. A STUDY OF THE ORIGIN OF LONGITUDINAL GROWTH STRESSES IN TREE STEMS. Bull. Kyushu Univ. For. No. 41, (169-76). [17 refs. [E.].]

83 TIMBER MANUFACTURING INDUSTRIES AND PRODUCTS

833.1

Orosz, I. 1968. SOME NONDESTRUCTIVE PARAMETERS FOR PREDICTION OF STRENGTH OF STRUCTURAL LUMBER. U.S. For. Serv. Res. Pap. U.S. For. Prod. Lab., Madison No. FPL 100, pp. 6. [8 refs.]
Suggests structural-lumber grading variables and functions that are capable of better strength predictions than strength ratio or modulus of elasticity alone.

84 PRESERVATION AND OTHER TREATMENTS TO IMPROVE THE PROPERTIES OF WOOD. DAMAGING INFLUENCES

841 WOOD PRESERVATION

Chiani, R. G. 1965. [DURABILITY TESTS OF TREATED AND UNTREATED FENCE POSTS IN PLOTS IN BUENOS AIRES CITY – RESULTS AT THE END OF THE SECOND YEAR.] Rev. for. argent. 9 (2): 49-53. [Span.]
Sixteen native and exotic species were used in the trials, and 7 impregnation methods, all of a type suitable for use on farms.

844 ATTACK BY PLANT ORGANISMS

Igmandy, Z., and Pagony, H. 1967. [DURABILITY OF WOOD OF POPLARS OF THE SECTION LEUCE.] Erdesz. Faipari Egyetem tud. Kozl., Sopron (1/2), (85-94). [5 refs. [Hu.ru.g.e.].]
A study of the resistance to decay of wood of Populus alba, P. canescens, P. tremula, P. alba X P. grandidentata and P. canescens X P. grandidentata, using Trametes [Polystictus] versicolor, T. [gallica f.] trogii, Pleurotus ostreatus and Coniophora cerebella as test fungi.

847 DRYING (SEASONING)

Horsky, D. 1971. [NATURAL DRYING OF POPLAR SAWN TIMBER.] Zbornik Vedeckych Prac Drevarskej Fakulty Vysokej Skoly Lesnickej a Drevarskej vo Zvolene 13-29 [Sk.ru.de., 9 ref.]
Describes studies on the yard drying of Populus 'Robusta', P. alba and P. 'Serotina' timber. Results showed the decisive influence of board thickness and position in the stack on drying rate, and it is concluded that natural air drying cannot be recommended for Poplar.

85 "GRADING" OF WOOD AND WOOD PRODUCTS

Pagony, H. 1965. [DETERIORATION AND INCIPIENT DECAY IN POPLARS.] Erdesz. Kutatas., Budapest 61 (1/3): 241-55. [8 refs. [Hu.hu.ru.g.].]
When 2-m sections, 25-30 cm. in diam., of March-felled Populus X marilandica, P. nigra, and P. alba were stored for > 1 year in Hungarian flood-plain stands, logs barked and/or treated with 5% DNOC did not deteriorate.

86 PULP INDUSTRIES

Constantinescu, O., and Popescu, G. 1970. [THE PAPERGRADE VALUE OF DIFFERENT POPLAR VARIETIES, NORMAL WOOD, AND TENSION WOOD.] Celuloza si Hirtie 19 (12): 422-427 + smries. [Ro.f.e.de.ru., NLL]
Reports the chemical composition, sulphate-pulping properties, and papermaking properties of whole wood of Populus 'Robusta', P. 'Celei', P. 'Cetate', P. tremula, P. nigra and P. alba aged 17-29 years, and normal and tension wood of P. 'Robusta'.

Grigoras, M., Asandei-Cernatesch, A., and Rozmarin, G. 1971. [THE CHEMISTRY OF THE POPLAR IN RUMANIA. IV. THE POLY-MOLECULARITY OF NATIVE CELLULOSE AND NORMAL SULPHATE CELLULOSE.] Celuloza si Hirtie 20 (4): 168-175 + smries. [Ro.f.e.ru.de., 32 ref. NLL]
Reports measurements of the degree of polymerization of cellulose in a range of Poplar woods by the nitration method.

Iancu, A., and Tocan, M. 1967. [STUDIES TO DETERMINE THE PAPER-MAKING VALUE OF DIFFERENT HYBRID BLACK POPLARS GROWN IN RUMANIA.] Celuloza si Hirtie, Bucuresti 16 (3/4): 81-9. [17 refs. [Rum.] N.L.L.]
The Poplars investigated were (1) Populus X serotina, (2) P. X robusta, (3) P. X marilandica, (4) P. x regenerata 'Celei', (5) P. 'Arges', (6) P. deltoides 'Virginiana cetate', and (7) native Rumanian P. nigra.

Jayme, G. 1968. THE EFFECT OF SPECIES AND ORIGIN UPON THE CHEMICAL COMPOSITION AND THE SUITABILITY OF POPLAR WOOD FOR PULPING. Transl. Dep. For. Can. No. 229, pp. 24. [16 refs. Transl. from Papier, Darmstadt 1947, 1 (9/10): 182-90.

89 OTHER FOREST PRODUCTS

892 VEGETABLE PRODUCTS

Medorizescu, M. 1974. [UTILIZATION IN THE FORM OF FODDER MEAL OF SOME WILD PLANT RESOURCES IN THE FOREST (LEAVES, HERBACEOUS PLANTS, SEEDS AND FRUIT RESIDUES).] Studii si Cercetari, Institutul de Cercetari si Amenajari Silvice (Silvicultura) 30: 159-176 [Ro.e.de.ru., 18 ref.]
Many of the products were richer in certain substances (carotene, etc.) than standard fodders, and the ratio of digestible protein to nutritive units (starch equivalent) approached that of lucerne hay in the case of leaf flours of R. pseudoacacia and Populus alba.

892.7

Slavik, I., and Pasteka, M. 1969. [THE PROPERTIES AND COMPOSITION OF POPULUS ALBA SEED FIBRES.] Drev. Vyskum 2: 53-9. [Slovak.g.e., 10 refs. P.R.]
Presents and discusses data from chemical analyses, drawing comparisons with cotton fibres and with P. alba heartwood, mainly in connexion with lignin content, and with kapok. Data are also included on some physical properties.

9 FORESTS AND FORESTRY

FROM THE NATIONAL AND INTERNATIONAL POINTS OF VIEW

904 GENERAL REGIONAL ACCOUNTS OF FORESTS AND FORESTRY

Barthel, E. V. 1965. [THE MUNICIPAL FOREST OF BREISACH: 700 YEARS OF FOREST HISTORY IN THE FLOOD-PLAIN OF THE UPPER RHINE.] Schriftenreihe der Landesforstverwaltung Baden-Wurttemberg, Stuttgart No. 18, pp. 251. [G.] Price DM. 24. From reviews in Allg. Forstzeitschr. 20 (30/31), 1965 (484-5) [G.]; Arch. Forstw. 15 (2), 1966 (223). [G.]
Includes a description of the injurious effects on the forest of the training of the Rhine in the late 19th century and the subsequent building of the Grand Canal d'Alsace, which eliminated flooding and greatly lowered the water table.

P. BALSAMIFERA TO P. BEROLINENSIS

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

15 ANIMAL ECOLOGY

Gill, D. 1972. THE EVOLUTION OF A DISCRETE BEAVER HABITAT IN THE MACKENZIE RIVER DELTA, NORTHWEST TERRITORIES. Canadian Field-Naturalist 86 (3): 233-239 [E., 12 ref. NLL]
Traces the sequence of events that create a discrete habitat for Castor canadensis in the Mackenzie River.

16 GENERAL BOTANY

160 PLANT CHEMISTRY

Kull, U. 1973. [TEMPERATURE-INDEPENDENT ACCUMULATION OF RAFFINOSE SUGARS IN POPLAR BARK.] Barichte der Deutschen Botanischen Gesellschaft 86 (10/12): 499-503 [De.e., 19 ref. OBD]
After outdoor cultivation for one year, cuttings of Populus 'Oxford'

ere transferred in September either to an unheated greenhouse or a hothouse (25° C). The contents of stored carbohydrates were easured at monthly intervals in leaves up to the time of yellowing, id in bark until March of the following year.

arl, I. A., and Darling, S. F. 1971. PHENOLIC EXTRACTIVES F THE LEAVES OF POPULUS BALSAMIFERA AND OF P. RICHOCARPA. Phytochemistry 10 (11): 2844-2847. [E., 16 ref.] *lthough the constituents of the two species were similar in general, veral important differences were noted.*

arl, I. A., and Darling, S. F. 1968. STUDIES ON THE LEAVES F THE FAMILY SALICACEAE XI. THE HOT WATER XTRACTIVES OF THE LEAVES OF POPULUS BALAMIFERA. Phytochemistry, Oxf. 7 (10): 1845-9. [11 refs. .R.S.]
resh leaves cut from 5-year trees in May and Sept. contained licin, salicyl alcohol, pyrocatechol, (−)-3-hydroxy-5-phenylvaleric id (a), trichocarpin, cinnamic acid (b), and p-coumaric acid (c), uantities being less in Sept. than in May; (a), (b), and (c) are ported for the first time in Poplar leaves, and (a) is a first record om a plant source.

160.2

ull, U., and Jeremias, K. 1972. [THE FATTY ACID COMOSITION OF THE SAPONIFIABLE LIPIDS FROM BARKS OF OPULUS BALSAMIFERA.] Z. Pflanzenphysiol., Stuttgart 68: 5-62. Ref. in Ber. Biochem. Biologie, Berlin 378 (5): 486-487.

161 PHYSIOLOGY

omanski, R., and Kozlowski, T. T. 1968. VARIATIONS IN INETIN-LIKE ACTIVITY IN BUDS OF BETULA AND OPULUS DURING RELEASE FROM DORMANCY. Repr. from anad. J. Bot. 46 (4): 397-403. [35 refs.]
ormancy of buds of Betula papyrifera and Populus balsamifera uttings was broken, and extracts of buds at various stages of ormancy were separated. The amount of kinetin-like activity at ese stages was then determined by observing the effects of active f values of bud extracts on senescence of Raphanus plants.

lemm, M., and Klemm, W. 1964. [THE USE OF RADIOACTIVE SOTOPES FOR A CONTINUOUS RECORD OF THE VELOCITY F THE TRANSPIRATION STREAM IN TREES.] Flora, Jena 54 (1): 89-93. 5 refs. [G.g.] O.B.D.
njections of a solution containing P^{32} were successfully used in racing the day-by-day course of the transpiration stream in Populus v. 'Oxford' and Betula verrucosa.

ull, U. 1970. [EFFECTS OF PHENYLBORIC ACID ON THE TORAGE OF CARBOHYDRATES IN THE VEGETATIVE ARTS OF PLANTS.] Biochem. Physiol. Pflanzen 161 (4): 330-41. G.e., 19 refs. O.B.D.]
henylboric acid was applied to the apex of young plants of four ifferent species, and to cuttings of a hybrid of Populus balsamifera. pecies in which longitudinal growth was inhibited, showed a rise in ontents of stored carbohydrates, but in the Poplar, growth was not arkedly inhibited and the effects on the storage of carbohydrates ere slight.

eskovceva, I. I. 1967. [FORMATION OF SPOROGENOUS CELLS N CULTURES OF ISOLATED ♂ FLOWER BUDS OF WOODY LANTS. (THE EFFECT OF HETEROAUXIN AND KINETIN).] iziol. Rast. 14 (4): 710-8. [25 refs. [Ru.ru.e.] A.P.B.]

eskovceva, I. I., and Minina, E. G. 1965. [CYTOCHEMICAL TUDY OF THE MALE SPOROGENOUS CELLS OF BALSAM OPLAR IN CONNEXION WITH QUESTIONS OF SEXUAL PECIALIZATION.] Fiziol. Rast. 12 (5): 832-6. 13 refs. [Ru.ru.e.] .P.B.

astorgueva, E. Ya. 1971. [THE ANNUAL CHANGES IN THE VATER REGIME OF CERTAIN WOODY SPECIES IN THE TEPPE REGIONS OF KHAKASIA.] In Fiziologobiokhimicheskie sobennosti drevesnykh rastenii Sibiri. Izdatel'stvo Nauka, Moscow. p. 77-84. [Ru., 22 ref.]
Tabulates data on the transpiration and content of total and bound ater of shoots and leaves of Betula verrucosa, Larix sibirca, and opulus balsamifera in shelterbelts in S. central Siberia in 1967-68. esults are discussed in relation to the relative frost hardiness of the hree species.

Roscina, V. D. 1965. ['PHYTOCIDES' AND THE MOVEMENT OF CHLOROPLASTS.] Fiziol. Rast. 12 (3): 489-93. 15 refs. [Ru.e.] A.P.B.
Comminuted and undamaged leaves of Prunus racemosa, Sorbus aucuparia, Populus balsamifera, Syringa vulgaris, and Rhus typhina, and Allium Sativum bulbs, were used as sources of volatile 'phytocides' and the effect of these on chloroplast movement in Elodea canadensis was investigated.

Wang, S.-S. 1964. [SPEED OF THE ASCENDING [SAP] FLOW IN WOODY SPECIES.] Dok. Akad. Nauk SSSR 156 (3): 706-7. 6 refs. [Ru.] O.R.S.
At various dates during summer (with differing air temperatures and r.h.), a solution of $Na_2HP^{32}O_4$ was injected into stems of Populus balsamifera, Quercus robur, Betula verrucosa and Picea abies, all 5-10 years old, at a height of 10-20 cm. above the root collar. The trees were later felled, sectioned, and the radioactivity and speed of sap flow determined.

163 EMBRYOLOGY

Nikolaeva, E. S. 1964. [EMBRYOLOGY OF POPULUS BALSAMIFERA.] Bot. Z. 49 (11): 1644-9. 5 refs. [Ru.]
With detailed drawings of ovule, embryo, endosperm, etc.

164 MORPHOLOGY

Danilin, M. A. 1973. [SEXUAL DIMORPHISM IN SOME DIOECIOUS TREE SPECIES.] Lesovedenie No. 6, 90-93 [Ru.e., 20 ref.]
A statistical analysis of the results of biometric studies made at the Krasnoyarsk instructional and experimental leskhoz on the dimensions of flower buds, petioles and leaves in Populus tremula, P. balsamifera, Acer negundo, Salix caprea and Hippophae rhamnoides.

Roller, K. J. 1972. THE HYBRID (POPULUS DELTOIDES X BALSAMIFERA) X P. NIGRA VAR. BETULIFOLIA IN MANITOBA. In Proceedings, 19th Northeastern Forest Tree Improvement Conference 1971, 77-81 [E., 8 ref.]
A study was made to determine the segregation of certain characters of the parent trees in the hybrid progeny from controlled pollination of P. deltoides X P. balsamifera. Leaf shape, time of flushing, sexual maturity and height growth were the traits examined in 88 hybrid trees.

Vasil'ev, A. E. 1966. [CERTAIN FEATURES OF THE SUBMICROSCOPIC STRUCTURE OF THE SECRETORY SYSTEM OF PLANTS AS RELATED TO ITS FUNCTIONAL SIGNIFICANCE.] Rast. Resursy, Moskva 2 (3): 331-40 + 5 plates. [27 refs. [Ru.ru.] N.L.L.]
Reviews world literature, and gives results of an electron-microscope investigation of the epithelial cells of resin ducts in needles of Pinus sibirica and in bark of Picea abies, and of the glandular cells of extra-floral nectaries on leaves of Populus balsamifera and P. suaveolens.

165 PHYLOGENY, EVOLUTION, ETC.

Dragavtsev, V. A., and Nechiporenko, V. N. 1972. [DISTRIBUTION OF GENOTYPICAL DEVIATIONS OF STATISTICALLY ELEMENTARY QUANTITATIVE CHARACTERS IN PLANT POPULATIONS.] Genetika 8 (6): 23-33 [Ru.e., 16 ref.] From Plant Breeding Abstracts 43, 2270.
Various circumstances are discussed in which the genotypic variation of a certain character may remain constant, even if the mean for the population should change, such a character being defined as an 'elementary quantitative character'.

Vincent, G., and Polnar, M. 1968. [GENETIC CONDITIONS OF HETEROTIC GROWTH IN POPLAR HYBRIDS.] Lesn. Cas. 14 (8): 701-18. [Cz.ru.e.g., 17 refs.]
Preliminary results of crossing Populus X generosa with P. nigra and P. X serotina, and P. 'grandis' with P. X serotina and P. tacamahaca, suggest that heterosis obtained by means of inter-section crosses produces rapid early growth but does not increase resistance (survival %s).

17 SYSTEMATIC BOTANY

176.1

Brayshaw, T. C. 1965. THE STATUS OF THE BLACK COTTONWOOD (POPULUS TRICHOCARPA TORREY AND GRAY). Repr.

from Canadian Field-Naturalist 79 (2), (91-5). 8 refs.
Though the characters of ♀ catkins of Tacamahaca Poplars were found to be predominantly of the Populus balsamifera type east of Saskatchewan and of the trichocarpa type west of the Rocky Mts., this was not invariable, and in large areas of Alberta and British Columbia they were intermediate.

Viereck, L. A., and Foote, J. M. 1970. THE STATUS OF POPULUS BALSAMIFERA AND P. TRICHOCARPA IN ALASKA. Canad. Fld. Nat. 84 (2): 169-73. [15 refs. N.L.L.]

18 PLANT ECOLOGY

181 MODE OF LIFE, AUTECOLOGY. SILVICULTURAL CHARACTERS OF TREES

Sakai, A., and Weiser, C. J. 1973. FREEZING RESISTANCE OF TREES IN NORTH AMERICA WITH REFERENCE TO TREE REGIONS. Ecology 54 (1): 118-126 [E., 31 ref.]
Dormant one-year-old twigs of ca. 70 tree species (including P. deltoides) were collected during midwinter from five regions of N. America (Rocky and Western Mountain, Northern, Pacific Coast, Southeastern Coast, and Central and Eastern Lowland) and studied for freezing resistance.

181.31

Braun, H. J. 1973. [THE GROWTH OF POPLARS UNDER CONDITIONS OF AN ALTERNATING OR CONSTANT HIGH WATER TABLE.] Allgemeine Forst- und Jagdzeitung 114 (5/6): 89-91 [De.e.f., 5 ref.]

Fedorova, A. I., and Elagina, N. N. 1969. [WATER SUPPLY OF AGRICULTURAL SHELTERBELTS ESTABLISHED BY THE CHESSBOARD METHOD IN N. KAZAKHSTAN.] Lesoved., Moskva (3), (66-74). [5 refs. [Ru.e.].]
Tabulates data on the soil moisture under three shelterbelts aged 7-9 years.

181.5

Hellum, A. K. 1973. SEED STORAGE AND GERMINATION OF BLACK POPLAR. Canadian Journal of Plant Science 53 (1): 227-228 [E., 1 ref. ORE]
In a storage trial on seed collected in June/July, viability of P. balsamifera seed declined slowly over the first 130 days (from 94% to 82%, in a sealed glass jar at 7° C) and then fell rapidly (by 0.7% per day). It is recommended that seeds should be germinated within 4 months of ripening.

Newhouse, M. E., and Madgwick, H. A. I. 1968. COMPARATIVE SEEDLING GROWTH OF FOUR HARDWOOD SPECIES. For. Sci. 14 (1): 27-30. [6 refs.]

Raju, M. V. S., Coupland, R. T., and Steeves, T. A. 1966. ON THE OCCURRENCE OF ROOT BUDS ON PERENNIAL PLANTS IN SASKATCHEWAN. Canad. J. Bot. 44 (1): 33-7 + 2 photos. 15 refs. O.R.S.
Twenty-six native and 12 introduced dicotyledonous species in S. Saskatchewan, including Salix interior, Populus balsamifera, P. tremuloides and many forest weeds, produced adventitious buds on roots.

181.6

Maini, J. S. 1966. APICAL GROWTH OF POPULUS SPP. I. SEQUENTIAL PATTERN OF INTERNODE, BUD, AND BRANCH LENGTH OF YOUNG INDIVIDUALS. Canad. J. Bot. 44 (5): 615-22. [12 refs. [E.e.f.] O.R.S.]

181.8

Bachelard, E. P., and Wightman, F. 1973. BIOCHEMICAL AND PHYSIOLOGICAL STUDIES ON DORMANCY RELEASE IN TREE BUDS. I. CHANGES IN DEGREE OF DORMANCY, RESPIRATORY CAPACITY, AND MAJOR CELL CONSTITUENTS IN OVERWINTERING VEGETATIVE BUDS OF POPULUS BALSAMIFERA. Canadian Journal of Botany 51 (12): 2315-2326 [E.f., 35 ref. ORS]

Bachelard, E. P., and Wightman, F. 1974. BIOCHEMICAL AND PHYSIOLOGICAL STUDIES ON DORMANCY RELEASE IN TREE BUDS. II. CHANGES IN ENDOGENOUS GROWTH SUBSTANCES AND A POSSIBLE MECHANISM OF DORMANCY RELEASE IN OVERWINTERING VEGETATIVE BUDS OF POPULUS BALSAMIFERA. Canadian Journal of Botany 52 (7): 1483-1489 [E.f., 33 ref. Cf. FA 35, 7474. ORS]

182 SYNECOLOGY, PLANT SOCIOLOGY

Viereck, L. A. 1970. FOREST SUCCESSION AND SOIL DEVELOPMENT ADJACENT TO THE CHENA RIVER IN INTERIOR ALASKA. Repr. from Arctic and Alpine Research 2 (1): 1-26. [32 refs.]

187 VEGETATION TYPES

Dirschl, H. J., and Coupland, R. T. 1972. VEGETATION PATTERNS AND SITE RELATIONSHIPS IN THE SASKATCHEWAN RIVER DELTA. Canadian Journal of Botany 50 (3): 647-675 [E.f., 58 ref. ORS]
Describes a 5-year study that attempted an ordering of the landscape pattern of the flood-plain complex of the delta, where the landscape components are flooded areas, meadows with stands of Salix spp., mixed Picea glauca/Populus balsamifera forest, and Sphagnum bogs dominated by Picea mariana, Larix laricina and Ericaceous shrubs.

2 SILVICULTURE

Mzavija, A. I. 1965. [RAISING THE PRODUCTIVITY OF THE FORESTS OF THE COLCHIS LOWLAND [CAUCASIA].] Lesn. Hoz. 18 (2): 12-4. [Ru.]
A note on the improvement of boggy Alnus barbata forests by drainage and heavy early thinning, and on planting Populus balsamifera, Platanus orientalis and Pinus taeda.

23 REGENERATION AND FORMATION OF STANDS

231 NATURAL REGENERATION

Wagg, J. W. B.s1964. WHITE SPRUCE REGENERATION ON THE PEACE AND SLAVE RIVER LOWLANDS. Publ. Dep. For. Can. No. 1069, pp. 35. 55 refs. [E.e.f.]

232 ARTIFICIAL REGENERATION

Blankenspeck, H. 1967. DER ANBAU VON BALSAMPAPPELN. ERFAHRUNGEN AUS DER SICHT EINEA MUNSTERLANDISCHEN PRIVATFORSTBETRIEBES. Forst-Holzwirt, Hann. 22 (9): 173-175, [4 Abb.]

Satalov, V. G. 1964. [POPLAR PLANTATIONS ON THE FLOODPLAIN OF THE MIDDLE DON.] Lesn. Z., Arhangel'sk 7 (6): 29-31. 1 ref. [Ru.]
A note on the performance of Populus nigra, P. balsamifera and P. X 'canadensis' plantations aged 9-20 years.

232.2

Gedenidze, A. A., and Papunidze, V. R. 1973. [EFFECT OF CULTIVATION OF SLIGHTLY SWAMPY SOILS ON THE GROWTH OF SOME WOODY SPECIES IN THE COLCHIS LOWLAND.] Subtropicheskie Kul'tury No. 3, 99-103 [Ru., NLL]
Compares the growth of young plantations of six broadleaved species established at four different spacings (1 X 1 to 6 X 6 m) on uncultivated sites in Soviet Georgia and on sites cultivated three times a year.

232.328

Cormack, R. G. H. 1965. THE EFFECTS OF CALCIUM IONS AND pH ON THE DEVELOPMENT OF CALLUS TISSUE ON STEM CUTTINGS OF BALSAM POPLAR. Canad. J. Bot. 43 (1): 75-83 + 9 photomicrographs. 39 refs. O.R.S.

Cormack, R. G. H., and Lemay, P. L. 1966. A FURTHER STUDY OF CALLUS TISSUE DEVELOPMENT ON STEM CUTTINGS OF

ALSAM POPLAR. Canad. J. Bot. 44 (1): 47-50 + 2 photos. 12 efs. O.R.S.

latveeva, G. V. 1966. [EFFECT OF AIR DRYING ON THE URVIVAL OF POPULUS BALSAMIFERA CUTTINGS.] Lesn. Z., rhangel'sk 9 (5): 48-51. [Ru.] [3 gphs. 1 tbl.]

232.5

irsova, A. I. 1965. [TRIALS WITH A PETROLEUM GROWTH UBSTANCE.] Lesn. Hoz. 18 (9): 52. [Ru.] 1 tbl.
bservations made after immersion of winter cuttings of Populus alsamifera in either a 0.005% petroleum growth substance (NRV) olution or a 0.001% IAA solution for 24 hr. before planting out onfirmed that treatment with NRV gave best results.

237 AMELIORATION OF FOREST SITES

aritonov, G. A. 1964. [THE USE OF MINERAL FERTILIZERS N [YOUNG] PLANTATIONS.] Lesn. Hoz. 17 (10): 43-7. 1 ref. Ru.]
n a series of trials in the Central Urals region, furrow-planted stands f Scots Pine, Larch, and Populus balsamifera on various soils were reated for the first few years by (1) conventional loosening of the oil 1, 2, 3 or 4 times a year, or (2) fertilizing once or twice a year ith N, P, or NP, sometimes in combination with soil loosening. For omparison, other plots were sprayed with 2,4-D or mulched with olythene film. Analysis of height growth and costs indicates that, here moisture is favourable but labour scarce, fertilizer application s one of the cheapest and most effective methods of encouraging oung plantations.

238 TIMBER PLANTATION CROPS REQUIRING SPECIAL TREATMENT

ange, O. 1967. DER ANBAU VON BALSAMPAPPELN HAT ORST- UND HOLZWIRTSCHAFTLICH EINE ZUKUNFT. Holz-entralbl., Stuttg. 93 (78): S.1233, [1 Abb., 6 Lit. Ang.]

ange, O. 1969. FORSTLICHE LANDSCHAFTSPFLEGE UND NBAU VON BALSAMPAPPELN. Holz-Zentralbl., Stuttg. 95 (6): .64, [2 Abb.]

24 TENDING OF STANDS AND TREES

243 OPENING OF THE CANOPY (INCREMENT FELLINGS, OVERHEAD RELEASE AND IMPROVEMENT FELLINGS)

ratt, R. H. M. 1966. AERIAL SPRAYING WITH 2,4-D to liminate Trembling Aspen. Pulp Paper Mag. Can. 67 (9): WR460 – VR462. [10 refs.]

245 TENDING OF TREES

Temirgaliev, Sh. M. 1971. [THE AGRICULTURAL AND ECONOMIC EFFICIENCY OF USING HERBICIDES IN TREE SHELTERBELTS ON ERODED SOILS.] Vestnik Sel'skokhozyaistvennoi Nauki, Kazakhshoi SSR 15 (11): 81-83 [Ru.kazakh]
Sites for planting Populus balsamifera shelterbelts [in Soviet Central Asia] were prepared by bare fallowing and autumn cultivation to a depth of 50 cm. Simazine at 5 kg/ha, applied in spring just after planting, gave only 47-70% control of weeds: 3-7 hand weedings were also needed over three growing seasons. Dalapon + 2,4-D (amine) applied at 7 + 2 kg/ha in June, after simazine treatment, gave 84-95% control at the end of the growing season and obviated hand weeding. Herbicides reduced weeding costs over three seasons by 54% compared with hand weeding and reduced the labour requirement from 30 to 5.64 man-days/ha.

26 COMBINATIONS OF FORESTRY WITH AGRICULTURE

266 SHELTERBELTS, WINDBREAKS

Fedorova, A. I. 1964. [MOISTURE SUPPLY OF YOUNG POPLAR SHELTERBELTS IN S. CENTRAL SIBERIA.] Pocvoved. (9), (33-44). 6 refs. [Ru.e.] A.P.B.

Fomin, D. M. 1964. [TRIAL IN GROWING HORTICULTURAL SHELTERBELTS WITH LARGE PLANTING STOCK.] Lesn. Hoz. 17 (7): 57-8. [Ru.]
Describes the successful establishment of a belt on chernozem, using Morus alba (4 years old, 1·0 m. tall), Populus balsamifera (5 years, 2 m.), Fraxinus excelsior (5 years, 2·2 m.), and Caragana arborescens (3 years, 0·7 m.).

Popova, O. S., Il'inykh, L. A., and Popov, V. P. 1973. [GROWTH AND WATER SUPPLY OF SHELTERBELTS IN THE KULUNDA STEPPE.] Pochvovedenie No. 3, 91-96 [Ru.e., 4 ref. CGB]

Vasil'ev, M. E. 1965. [NEW DESIGN OF SHELTERBELTS FOR THE VIRGIN LANDS OF W. SIBERIA AND N. KAZAKHSTAN.] Lesn. Z., Arhangel'sk 8 (5): 44-9. [Ru.ru.]
Belts consisting of Populus balsamifera, Betula verrucosa, Ulmus pumila var. arborea, U. laevis and Caragana arborescens 15-20 years old and having 8-15 rows, were converted to produce belts consisting of 1-15 rows.

268 PASTURED FORESTS. GRAZING ON FOREST AND OPEN RANGES

Canada Dept. of Agriculture. 1973. REPORT, RESEARCH STATION REGINA, SASKATCHEWAN: CONTROL OF BRUSH ON ASPEN PARKLAND. In Research Branch Report 1972 Canada Department of Agriculture. 254 [E.]

4 FOREST INJURIES AND PROTECTION

42 INJURIES FROM INORGANIC AGENCIES (EXCLUDING FIRES)

425 CHEMICAL INFLUENCES (ATMOSPHERIC)

LeBlanc, F., Rao, D. N., and Comeau, G. 1972. THE EPIPHYTIC VEGETATION OF POPULUS BALSAMIFERA AND ITS SIGNIFICANCE AS AN AIR POLLUTION INDICATOR IN SUDBURY, ONTARIO. Canadian Journal of Botany 50 (3): 519-528 [E.f., 19 ref. ORS]
P. balsamifera is fairly resistant to SO_2 and is the only relatively abundant tree species throughout the Sudbury area, where SO_2 pollution from nickel smelting is widespread and severe.

LeBlanc, F., Rao, D. N., and Comeau, G. 1972. INDICES OF ATMOSPHERIC PURITY AND FLUORIDE POLLUTION PATTERN IN ARVIDA, QUEBEC. Canadian Journal of Botany 50 (5): 991-998 + 1 pl. [E.f., 11 ref. ORS]
Indices of atmospheric purity (IAP) of 42 sites, located in all directions from the aluminium factory at Arvida and extending over an area of ca. 250 km^2, were determined on the basis of the phytosociology of epiphytes of Populus balsamifera.

Nikolaevskij, V. S. 1968. [THE ROLE OF SOME OXIDIZING SYSTEMS IN THE RESPIRATION AND GAS RESISTANCE OF PLANTS.] Fiziol. Rast. 15 (1): 110-5. [14 refs. [Ru.ru.e.] A.P.B.]
Presents and discusses the results of studies made to compare the effect of exposure to SO_2 on the respiration mechanism of resistant and non-resistant plants.

44 DAMAGE BY HARMFUL PLANTS. VIRUS DISEASES

441 FOREST WEEDS

Corns, W. G., and Dai, T.-S. 1967. EFFECTS OF ADDED SURFACTANT ON TOXICITY OF PICLORAM, 2,4-D AND 2,4,5-T TO POPULUS TREMULOIDES MICHX. AND P. BALSAMIFERA L. SAPLINGS. Canad. J. Pl. Sci. 47 (6): 711-2. [5 refs. O.R.E.]

In greenhouse trials, the surfactant Atlox 210 considerably increased the effectiveness of picloram, and of picloram plus 2,4-D in killing young Poplars, but only in some cases did it slightly improve the effects of esters of 2,4-D and 2,4,5-T.

Kostromin, M. 1973. [THE USE OF SIMAZINE AND ATRAZINE IN THE FOREST SHELTERBELTS OF N. KAZAKHSTAN.] Khimiya v Sel'skom Khozyaistve 11 (1): 43-45 [Ru., 6 ref.]
Weeds must be controlled for 5 years, until canopy closes, in shelterbelt plantations in the steppes.

Sharma, M. P., and Vanden Born, W. H. 1970. FOLIAR PENETRATION OF PICLORAM AND 2,4-D IN ASPEN AND BALSAM POPLAR. Weed Science, Urbana 18 (1): 57-63.
In laboratory experiments, penetration of picloram and 2,4-D into detached leaves of Populus tremuloides was enhanced by high r.h. and by the addition of a surfactant (Atlox 210) at 1% (volume/volume). The influence of the surfactant was greater for picloram and the dimethylamine salt of 2,4-D than for the ethyl or butoxyethanol ester of 2,4-D.

Temirgaliev, S. M. 1971. [THE AGRICULTURAL AND ECONOMIC EFFICIENCY OF USING HERBICIDES IN TREE SHELTERBELTS ON ERODED SOILS.] Vestnik Sel'skokhozyaistvennoi Nauki, Kazakhskoi SSR 15 (11): 81-83. [Ru.kazakh. From Weed Abstracts 21, 2990.]

443 FUNGI AND BACTERIA

Hawksworth, D. L. 1972. HYPOXYLON MAMMATUM. CMI Descriptions of Pathogenic Fungi and Bacteria No. 356, 2 pp. [E.]
Describes H. mammatum, a cause of perennial cankers leading to the death of a number of hardwood species and Picea spp. It is particularly important for Poplars, especially Populus grandidentata, P. tacamahaca [P. balsamifera] and P. tremuloides. Several formae speciales may exist.

Milatovic, I., and Saric, A. 1966. [SPREAD OF CERTAIN SPECIES OF RUST FUNGI IN NURSERIES.] Sum. List 90 (11/12): 516-9. [6 refs. [Serb.e.e.].]
A study at the Banova Jaruga forest nursery, Croatia, on Melampsora allii-populina, attacking Poplars of section Aigeiros, and M. larici-populina, attacking sections Tacamahaca and Aigeiros.

Saho, H., and Takahashi, I. 1968. [TYMPANIS SPP. CAUSING DIE-BACK DISEASE OF WOODY PLANTS NEWLY FOUND IN HOKKAIDO.] J. Jap. For. Soc. 50 (11): 336-44. [12 refs. [Jap.jap.e.].]
Describes morphological characters, with emphasis on primary ascospores, of: T. abietina on Abies sachalinensis; T. hansbroughiana on Pseudotsuga menziesii; T. hypopodia on Pinus strobus and P. sylvestris (common on planted trees ca. 10 years old); T. laricina on Larix spp.; T. pithya on P. strobus and P. sylvestris; and T. spermatiospora on Populus berolinensis X P. maximowiczii.

Zalasky, H. 1964. THE HISTOPATHOLOGY OF MACROPHOMA TUMEFACIENS INFECTIONS IN BLACK POPLAR. Canad. J. Bot. 42 (4): 385-91 + 32 photos. 14 refs. O.R.S.

Zalasky, H. 1964. NOMENCLATURE AND DESCRIPTION OF DIPLODIA TUMEFACIENS (SHEAR) ZALASKY [MACROPHOMA TUMEFACIENS SHEAR APUD HUBERT]. Repr. from Canad. J. Bot. 42 (8): 1049-55 + 15 photos. 23 refs.
The fungus, which causes galls on Populus balsamifera, P. grandidentata, P. tremula, P. tremuloides and P. trichocarpa, is transferred to Diplodia. The appearance of the pycnidia differs in the cork and cortical tissues of different hosts.

Zalasky, H. 1968. RHYTIDIELLA MORIFORMIS N. GEN. N. SP. CAUSING ROUGH-BARK OF POPULUS BALSAMIFERA. Canad. J. Bot. 46 (11): 1383-7 + 4 plates. [11 refs. Smry. 16 figs.]

45 DAMAGE BY ANIMALS

453 INSECTS

Titus, F. A., and Underwood, G. R. 1966. LEAF-MINING SAWFLY ON POPLARS. Bi-m. Progr. Rep. Dep. For. Can. 22 (1): 1.
Messa populifoliella has been found in New Brunswick on Carolina Poplars, occasionally on Lombardy Poplars, and rarely on Balsam Poplars.

Whitney, H. S., and Baranyay, J. A. 1968. AN UNDESCRIBED GALL MIDGE LEAF SPOT OF BALSAM POPLAR. Phytopathology 58 (2): 262-3.
The first symptoms of the disorder, described from Alberta, are small chlorotic papillae each containing a cecidomyiid larva. Various fungi were isolated from the larger necrotic spots developing, but none consistently, suggesting that the injury caused by the larva renders the leaf tissue liable to fungal attack.

Wong, H. R., and McLeod, B. B. 1965. TWO SPECIES OF GALL-PRODUCING SAPERDA IN MANITOBA AND SASKATCHEWAN. Bi-m. Progr. Rep. Dep. For. Can. 21 (5): 3.

Wong, H. R., and Melvin, J. C. E. 1973. INSECTS ASSOCIATED WITH TREES DAMAGED BY HYDROCARBON CONDENSATE IN THE STRACHAN AREA, ALBERTA. Information Report, Northern Forest Research Centre, Canada No. NOR-X-74, 19 pp. [E., 7 ref.]

5 FOREST MENSURATION

52 MEASUREMENTS OF STEM DIMENSIONS AND VOLUME OF TREES, STANDS, FORESTS AND TIMBER

524.3

Dippold, R. M., and Farr, W. A. 1971. VOLUME TABLES AND EQUATIONS FOR WHITE SPRUCE, BALSAM POPLAR, AND PAPER BIRCH OF THE KUSKOKWIM RIVER VALLEY, ALASKA. US For. Serv. Res. Note Pacif. Nthwest. For. Range Exp. Sta. No. PNW-147, pp. 8 [4 ref.]
Presents: equations for merchantable volume of Picea glauca, Populus balsamifera, and Betula papyrifera; a cubic-foot volume table (d.b.h. 5-28 in, total height 35-110 ft) and two board-foot volume tables (International 1/4 inch and Scribner; d.b.h. 9-28 in, total height 35-110 ft) for P. glauca; and a cubic foot volume table (d.b.h. 5-19 in. total height 30-85 ft) for P. balsamifera and B. papyrifera combined.

Haack, P. M. 1963. VOLUME TABLES FOR TREES OF INTERIOR ALASKA. U.S. For. Serv. Res. Note Nth. For. Exp. Sta. No. NOR-5, pp. 11. 3 refs.
Gives bd.ft. and cu.ft. tables for: Picea glauca; Populus tremuloides and Betula papyrifera; and Populus balsamifera and P. trichocarpa.

Ker, M. F. 1974. METRIC TREE VOLUME TABLES FOR NEWFOUNDLAND. Information Report, Newfoundland Forest Research Centre, Canada No. N-X-122, 24 pp. [E., 3 ref.]

56 INCREMENT; DEVELOPMENT AND STRUCTURE OF STANDS

Langhammer, A., and Langlien, K. R. 1971. [FIBRE PRODUCTION ON SHORT ROTATIONS: (I) TREE SPECIES, ROTATION PERIOD, YIELD; (II) PROFITABILITY OF GROWING BALSAM POPLAR.] Norsk Skogbr. 17 (13/14; 15/16): 272-4; 294-6. [No., 14 ref.]

58 SURVEYING AND MAPPING. AERIAL SURVEY

Rohde, W. G., and Olson, C. E., Jr., 1970. DETECTING TREE MOISTURE STRESS. Photogramm. Engng. 36 (6): 561-6. [12 refs.]

8 FOREST PRODUCTS AND THEIR UTILIZATION

81 WOOD AND BARK: STRUCTURE AND PROPERTIES

812.3

orn, J. D. 1966. SPECIFIC GRAVITY OF INCREMENT CORES ROM INTERIOR ALASKA TREES. U.S. For. Serv. Res. Note th. For. Exp. Sta. No. NOR-19, pp. 4 [6 refs.]
ean values from increment cores of 1065 trees (Picea spp., Populus emuloides and P. balsamifera, Betula papyrifera) are tabulated; ensities may be somewhat higher to the W. of Alaska. Values are milar to or exceed those reported from other parts of N. America.

83 TIMBER MANUFACTURING INDUSTRIES AND PRODUCTS

832.1

anks, L. F., and Swanson, C. W. 1967. LUMBER GRADE YIELDS ROM PAPER BIRCH AND BALSAM POPLAR LOGS IN THE USITNA RIVER VALLEY, ALASKA. U.S. For. Serv. Res. Pap. ıcif. Nthwest. For. Range Exp. Sta. No. PNW-51, pp. 29. [5 refs.]
umber grade yields and overruns by log grade and scaling diameter ere determined for 162 logs of Betula papyrifera and 174 of opulus balsamifera. Results are tabulated.

84 PRESERVATION AND OTHER TREATMENTS TO IMPROVE THE PROPERTIES OF WOOD. DAMAGING INFLUENCES

841 WOOD PRESERVATION

jovik, L. R., Roth, H. G., and Davidson, H. L. 1972. REATMENT OF ALASKAN SPECIES [WITH PRESERVATIVE] Y DOUBLE-DIFFUSION AND MODIFIED DOUBLE-IFFUSION METHODS. USDA Forest Service Research Paper, orest Products Laboratory, Madison No. FPL 182, 19 pp. [E., 1 f.]

847 DRYING (SEASONING)

ackay, J. F. G. 1974. REDUCE DRYING TIMES AND MEET OISTURE-CONTENT KILN CLUBS, EUGENE, OREGON, IMENSION LUMBER. In Proceedings, 25th Annual Meeting of estern Dry Kiln Clubs, Eugene, Oregon, May 9-10 1974. Van-uver, Canada; Canadian Forestry Service. 11 pp. [E., 4 ref. PR]
high-temperature schedule has been developed which includes a ng high-humidity period to dissipate moisture from wet pockets thout over-drying the remainder of the wood. It results in shorter drying times and more economical drying than methods employed hitherto.

86 PULP INDUSTRIES

862 COMPOSITE MATERIALS MADE WHOLLY OR PARTLY OF WOODY MATTER

Carroll, M. N., Clermont, L. P., and Leblanc, G. 1973. pH AND BUFFER CAPACITY OF CANADIAN WOODS IN RELATION TO PARTICLEBOARD MANUFACTURE. Information Report, Eastern Forest Products Laboratory, Canada No. OP-X81, iv + 2 pp. [E.f., TRADA]
The pH of water suspensions of 36 Canadian wood species were measured.

Haygreen, J. G., and Gertjejansen, R. O. 1972. INFLUENCE OF THE AMOUNT AND TYPE OF PHENOLIC RESIN ON THE PROPERTIES OF A WAFER-TYPE PARTICLEBOARD. Forest Products Journal 22 (12): 30-34 [E., 5 ref.]

Hujanen, D. R. 1973. COMPARISON OF THREE METHODS FOR DIMENSIONALLY STABILIZING WAFER-TYPE PARTICLE-BOARD. Forest Products Journal 23 (6): 29-30 [E., 5 ref.]

89 OTHER ("MINOR") FOREST PRODUCTS

892.4

Pearl, I. A., and Darling, S. F. 1968. STUDIES ON THE BARKS OF THE FAMILY SALICACEAE XIX. CONTINUED STUDIES ON THE HOT WATER EXTRACTIVES OF POPULUS BALSAMI-FERA BARK. XX. VARIATION IN THE HOT WATER EXTRACTIVES OF P. BALSAMIFERA BARK. Phytochemistry, Oxf. 7 (10): 1851-3, 1855-60. [14 refs. O.R.S.]

Pearl, I. A., and Darling, S. F. 1969. INVESTIGATION OF THE HOT WATER EXTRACTIVES OF POPULUS BALSAMIFERA BARK. Phytochemistry 8 (12): 2393-6. [11 refs. O.R.S.]
Salicortin, trichocarposide, populoside, salicyloylsalicin, and dihydromyricetin were identified chromatographically, all for the first time in this species.

Pearl, I. A., and Pottenger, C. R. 1966. STUDIES ON THE HOT WATER EXTRACTIVES OF THE GREEN BARK OF POPULUS BALSAMIFERA. Tappi 49 (4): 152-4. [12 refs.]

9 FORESTS AND FORESTRY

FROM THE NATIONAL AND INTERNATIONAL POINTS OF VIEW

90 GENERAL

McClintock, D. 1973. THE TREE OF THE BALSAM OF PERU. Quart. J. For. 67 (2): 136-140.

P. CANADENSIS TO P. DAVIDIANA

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

16 GENERAL BOTANY

160 PLANT CHEMISTRY

Thieme, H., and Richter, R. 1966. [THE OCCURRENCE OF 1-p-COUMAROYL-β-D-GLUCOSE IN THE LEAVES OF POPULUS CANDICANS.] Pharmazie, E. Berlin 21 (4): 252-3. [5 refs. [G.] E.M.B.]
The substance, previously only known from flower petals and fruit, was isolated, in addition to salicin, salicortin and trichocarpin. It was also detected by paper chromatography in P. candicans bark, and in bark and foliage of P. trichocarpa.

Thieme, H. 1969. THE FLAVONOIDS OF THE SALICACEAE. 3RD REPORT: FLAVONOIDS OF THE LEAVES OF POPULUS CANDICANS. Pharmazie, E. Berlin 24: 783-4. [G., 8 refs. From abstr. in Hort. Abstr. 1970 40 (3), (No. 7014).]
Gives analytical data on quercetin-3-β-D-glucoside, myricetin-3-β-D-galactoside, luteolin-7-β-D-glucoside and quercetin.

162 PATHOLOGY AND TERATOLOGY

Tucovic, A., and Jovanovic, M. 1970. [A RARE CASE OF EARLY 'ANTHOCLADY' IN POPULUS CANDICANS.] Topola 14 (77/78): 3-6. [Serb.e., 15 refs.]
Describes and discusses an abnormality, observed on two trees in Jugoslavia. These, in June 1969, showed ♀ catkins, developing near the apex of leafy shoots, with fewer flowers than usual and some of the floral disks transformed into incompletely developed leaves.

164 MORPHOLOGY

Jovanovic, B., and Tucovic, A. 1964. [THE OCCURRENCE OF MONOECIOUS AND HERMAPHRODITE FLOWERS IN SOME HYBRID POPLARS.] Topola, Beograd 8 (44): 17-22. 6 refs. [Serb.f.]
Presents data on the flowering and crown form of (a) Populus tremula var. typica f. deliblatica X P. [alba var.] bolleana, and (b) P. canescens f. fraxinoides X P. [alba var.] bolleana, planted in 1959. Sexual polymorphism is more frequent in (a) than in (b).

165 PHYLOGENY, EVOLUTION, HEREDITY, ETC.

Einspahr, D. W. 1968. GROWTH AND NUTRIENT REQUIREMENTS OF HYBRIDS BETWEEN POPULUS CANESCENS AND POPULUS TREMULOIDES. Genet. Physiol. Note Inst. Paper Chem., Appleton, Wis. No. 4, pp. 17. [5 refs.]
Data from a sand-culture experiment in which the amounts of N, P, K, Ca and Mg were varied revealed that seedlings from the P. tremuloides X P. canescens cross grew faster (as reflected in green-weight production) than those from the P. canescens X P. tremuloides, P. tremuloides X P. tremuloides or P. canescens X P. canescens crosses.

Jovanovic, B., and Tucovic, A. 1969. [RESYNTHESIS OF THE GREY POPLAR POPULUS CANESCENS SM. F. FRAXINOIDES.] Sumarstvo 22 (11/12): 5-11. [Serb.e., 18 refs.]
The 11-year-old hybrid progeny of controlled crosses between P. tremula var. villosa f. deliblatica and P. X canescens included a tree with Ash-like bark. This was shown to be identical with the P. X canescens f. Fraxinoides already found in nature in parts of Jugoslavia.

Melchior, G. H., and Seitz, F. W. 1968. [STERILITY IN INTERSPECIFIC CROSSES WITHIN POPULUS SECT. AIGEIROS.] Silvae Genet. 17 (2/3): 88-93. [23 refs. [G.g.e.].]

Sheikh, M. I. 1973. SELECTION OF POPULUS CILIATA CLONES. Pakistan Journal of Forestry 23 (2): 149-154 [E.]
A preliminary report of trials begun in 1968, in which seed collected from six plus-trees was sown in a nursery in the Murree Forest Division near Rawalpindi. Initial selections from seedlings have indicated that there is considerable variation in progeny from the same seed source.

165.4

Kots, Z. P. 1970. [CYTOEMBRYOLOGICAL DATA ON CAUSES OF NON-BREEDING CAPACITY OF POPULUS CANDICANS AIT.] Lesovod Agrolesomelior 23: 96-108. [Ru.]

168 HISTOLOGY

Winton, L. L. 1968. TISSUE AND SUSPENSION CULTURES OF EUROPEAN GREY POPLAR. Abstr. in Amer. J. Bot. 55 (6, Part 2): 712. [O.B.D.]
Describes experiments with a strain of Populus canescens cultured since Oct. 1966 on Wolter's agar medium containing 0-5 mg./litre of 2,4-D.

17 SYSTEMATIC BOTANY

176.1 DICOTYLEDONEAE

Bartkowiak, S., and Bialobok, S. 1966. [INVESTIGATIONS ON MORPHOLOGICAL VARIABILITY IN ARTIFICIAL HYBRIDS – POPULUS X CANESCENS SMITH.] Arboretum Kornickie, Poznan 11, (105-51 + 1 tbl.). [70 refs. [Pol.e.e.].]
The results, given in detail in the 3-page English summary, show that there is no reason to consider P. X canescens as a 'good' species; it should be considered a hybrid between P. alba and P. tremula.

Baumeister, G. 1965. [IDENTIFICATION TEST PLANTINGS OF APPROVED POPULUS X CANESCENS CLONES.] Holzzucht Reinbek (3/4), (30-6). 2 refs. [G.g.] 10 photos. 2 dgms. 4 tbls.
Presents, on the basis of 4 years' test plantings of 11 out of 15 approved clones, preliminary characters for the identification of nursery plants of 7 clones.

Broekhuizen, J. T. M. van, and Tenge, O. R. 1969. [THE IDENTIFICATION OF POPULUS X CANESCENS 'WITTE VAN HAAMSTEDE' AND P. X CANESCENS 'LIMBRICHT'.] Ned. Bosb Tijdschr. 41 (2): 61-3. [2 refs. [Du.e.].]
Describes, with illustrations, distinctive leaf, petiole and branch characters.

Erdesi, J. 1965. [LOWLAND ASPEN AND GREY POPLARS IN THE VOJVODINA [JUGOSLAVIA].] Topola, Beograd 9 (52/54): 8-28. 18 refs. [Serb.f.]
Chiefly an ecological and systematic study of the two local taxa, P. tremula var. villosa and P. canescens var. gomboszii, describing many forms.

Tucovic, A., and Jovanovic, M. 1970. [A RARE CASE OF EARLY 'ANTHOCLADY' IN POPULUS CANDICANS.] Topola 14 (77/78): 3-6. [Serb.e., 15 refs.]
Describes and discusses an abnormality, observed on two trees in Jugoslavia. These, in June, showed ♀ catkins, developing near the apex of leafy shoots, with fewer flowers than usual and some of the floral disks transformed into incompletely developed leaves.

18 PLANT ECOLOGY

181 MODE OF LIFE, AUTECOLOGY. SILVICULTURAL CHARACTERS OF TREES

Koster, R. 1968. [POPULUS CANESCENS.] Populier, Wageningen 5 (3): 46-50. [Du.]

Marcet, E. 1964. [ASPEN AND ITS CULTIVATION.] Holzzucht, Reinbek 18 (1/2): 1-7. [G.]

181.31

Dabral, B. G. 1970. PRELIMINARY OBSERVATIONS ON POTENTIAL WATER REQUIREMENT IN PINUS ROXBURGHII, EUCALYPTUS CITRIODORA, POPULUS 'CASALE (488)' AND DALBERGIA LATIFOLIA. Indian For. 96 (10): 775-80 + 2 plates). [3 refs.]
Describes the method used, and presents data on monthly water consumption and dry-matter production for 10-12 months by 1-4 plants of each species aged 5, 6 or 12 months when the experiments were started.

181.32/.34

Einspahr, D. W. 1971. GROWTH AND NUTRIENT UPTAKE OF ASPEN HYBRIDS USING SAND CULTURE TECHNIQUES. Silvae Genet. 20 (4): 132-7. [E., 13 ref.]
The growth and nutrient requirements of seedlings of reciprocal hybrids between Populus canescens and P. grandidentata were compared with those of seedlings from the parent species.

181.4

Delvaux, J. 1967. [THE DEVELOPMENT OF STANDS. V. INTER-CLONAL COMPETITION IN POPLARS. VI. THE ACTION ON POPLARS OF MULTILATERAL TRANSPARENT AND OPAQUE SCREENS. VII. COMPETITION BETWEEN INDIVIDUAL POPLARS. VIII. EDGE EFFECTS IN POPLAR PLANTATIONS.] Trav. Sta. Rech. Groenendaal (Ser. B) No. 33, pp. 59. [18 refs. [F.f.du.e.].]

181.5

Valcic, V. 1966. [AN UNUSUAL DISCOVERY OF A GROUP OF POLYGAMOUS TREES OF POPULUS CANESCENS NEAR BELGRADE.] Topola, Beograd 10 (59/60): 29-32. [11 refs. [Serb.f.].]
Describes ♂ and ♀ buds and catkins, and discusses abnormalities in size of pollen grains of 23 trees showing bisexual characteristics.

2 SILVICULTURE

23 REGENERATION AND FORMATION OF STANDS

232 ARTIFICIAL REGENERATION

232.13

Bartkowiak, S., and Bialobok, S. 1964. [ANALYSIS OF GROWTH OF POPLAR HYBRIDS OF THE SECTION LEUCE.] Arboretum Kornickie, Poznan 9, (175-96). 18 refs. [Pol.ru.e.e.]
Height growth in 1955-62 was studied for the following hybrids grown from seed in 1953: Populus X canescens var. rogalinensis X P. tremula (hybrids PK 91 and PK 50), P. X canescens var. rogalinensis X P. X canescens var. pyramidalis (PK 89), P. tremula X P. X canescens var. pyramidalis (PK 49), and P. tremula X P. alba (PK 53).

232.325

Papp, L. 1966. [RAISING POPLAR SEEDLINGS WITH IRRIGATION]. Erdesz. Kutatas., Budapest 62 (1/3): 193-201. [5 refs. Hu.ru.g.] 1 photo. 5 gphs. 3 tbls.]

232.328

Detz, H., and Iersel, H. A. van. 1973. [GRAFTING OF POPULUS CANESCENS.] Populier 10 (1): 9-10 [Nl., 1 ref.]
A note discussing various methods of grafting P. canescens, including the use of a Bulgarian vine-grafting machine, which gave good results.

Janson, L. 1974. [INVESTIGATIONS ON THE EFFECT OF MINERAL FERTILIZING OF PARENT PLANTS OF TWO POPLAR CLONES OF SECT. LEUCE ON THE RESULTS OF THEIR VEGETATIVE PROPAGATION.] Prace Instytutu Badawczego Lesnictwa No. 477, 78 pp. [Pol.ru.de., 44 ref.]

Jobling, J. 1973. PRODUCTION AND USE OF PLANTING STOCK. VEGETATIVE PROPAGATION. In Report on Forest Research, Forestry Commission, UK. 36-37. [E., 3 ref.]

Latike, H. 1967. [THE USE OF MIST SPRAYS IN THE VEGETATIVE PROPAGATION OF FOREST SPECIES.] Arch. Forstw. 16 (6/9): 695-700. [3 refs. [G.].]
Briefly describes the technique developed at the Graupa plant-breeding station for large-scale propagation of Populus canescens, P. tremula and Salix caprea from green cuttings: mean rooting % was 64·4, 67·5, and 82·7 respectively.

Pena, J., and Vieitez, E. 1968. [THE ROOTING CAPACITY OF SALIX ATROCINEREA CUTTINGS.] An. Edafol. Agrobiol. 27 (5/6): 405-16. [16 refs. [Span.e.] E.M.B.]
In a study with 25-cm.-long cuttings of mature wood placed in a mist propagator at monthly intervals throughout the year, rooting response was ca. 100% from January to April, 85-94% from May to Aug., and declined to virtually nil from Sept. to Dec.

232.41

Nicolae, C., Oprica, A., and Clonaru, A. 1971. [THE INFLUENCE OF PLANT SIZE AND THE DEPTH OF SOIL PREPARATION ON THE DEVELOPMENT OF PLANTATIONS OF HYBRID BLACK POPLARS.] Stud. Cerc. Inst. Cerc. Silvice (Ser. I, Silv.) 28, (111-34). [Ro.de.ru., 25 ref.]
Populus 'Robusta R-16', and in some cases, P. 'Celei', were pit-planted in 1965 on five sites in the Danube dam-bank zone and on one site nearly free from flooding, in Rumania.

232.42

Singh, B., and Monappa, K. 1968. EFFECT OF DIFFERENT DEPTHS OF PLANTING AND MANURING ON THE GROWTH AND SURVIVAL OF POPLARS IN THE RAVINE LANDS 1/m. Indian For. 94 (9): 675-81 + 2 photos. [8 refs.]
Six treatments comprising three depths of planting (60, 90 and 120 cm.) with or without farmyard manure were tried for planting Populus 'Casale 488' in the ravine lands in Gujarat. The results of the study indicate that 120 cm. planting, with or without manure, gave significantly better height and diameter growth than the other depths.

Singh, B., Monappa, K., and Mistri, M. S. 1969. EFFECT OF DIFFERENT DEPTHS OF PLANTING AND MANURING ON THE GROWTH AND SURVIVAL OF POPLARS IN RAVINE LANDS – II. Indian For. 95 (8): 532-8. [7 refs.]
Deep planting generally enhanced growth and vigour, with significantly greater size, moisture % and relative turgidity of the leaves. Manuring had a similar effect but did not significantly increase leaf moisture % for any given depth of planting. Unmanured plants and shallow plantings showed a significantly higher saturation deficit in their leaves than manured plants or deep plantings. A combination of deep planting and manuring gave a greater drought resistance; survival after two years was 62·5% vs. 20% for shallow planting with or without manuring.

235 UNDERPLANTING, ADVANCE PLANTING, ETC. NURSES AND FORMATION OF MIXTURES

Keresztesi, B. 1967. [TRIALS OF ROBINIA ADMIXTURES TO CONIFER STANDS ON THE SANDY SITES BETWEEN DANUBE AND TISZA.] Erdesz. Kutatas., Budapest 63 (1/3): 129-48. [4 refs. [Hu.hu.ru.e.].]

Freudenberger, V. and Schlenker, S. 1965. [REFORESTATION OF FROSTY SITES. A TRIAL WITH NURSES IN THE BAAR [BADEN-WURTTEMBERG].] Allg. Forstzeitschr. 20 (9/10): 122, 124. [G.g.]
On clear-felled, good Triassic-limestone sites, Alnus incana proved the best nurse for Silver Fir introduced two years later. Salix

smithiana, grown from cuttings, and Populus 'Rochester' also gave good frost cover.

Keresztesi, B. 1968 [TRIALS OF ROBINIA PSEUDOACACIA ADMIXTURES ON SANDY SOILS IN THE REGIONS BETWEEN THE DANUBE AND THE TISZA.] Hung. For. Sci. Rev. (5-26). [Ru.]
A Russian version of work already noticed [see F.A. 30 No. 2272].

26 COMBINATIONS OF FORESTRY WITH AGRICULTURE

263 IRRIGATED FORESTS

Clonaru, A., et al. 1966. [GROWING HYBRID POPLARS AND WILLOWS ON THE DANUBE FLOOD-PLAIN.] Rev. Padurilor 81 (5): 264-7. [7 refs. [Rum.e.f.g.ru.].]

4 FOREST INJURIES AND PROTECTION

42 INJURIES FROM INORGANIC AGENCIES (EXCLUDING FIRES)

424 SOIL CONDITIONS; EROSION EFFECTS

Dimitri, L. 1973. [THE SALT TOLERANCE OF VARIOUS SPECIES AND CLONES OF POPLAR AND WILLOW UNDER LABORATORY AND FIELD CONDITIONS.] European Journal of Forest Pathology 3 (1): 24-38 [De.e.f., 15 ref.]
Studies (simulating winter conditions of salt spraying along motorways) were made near Hann, Munden, Germany, on 36 clones and hybrids of Salix spp. (a) and 10 clones each of Populus nigra (b) and P. X canescens (c), by dipping the ends of dormant shoots in 23 % NaCl.

44 DAMAGE BY HARMFUL PLANTS. VIRUS DISEASES

441 FOREST WEEDS

Banks, C. H. 1964. EFFICACY OF 2,4,5-TRICHLOROPHENOXYACETIC ACID IN CONTROLLING POPULUS CANESCENS REGENERATION. Bosb. Suid-Afr. No. 5, (99-105). [E.e.afr.]
Application techniques and dosages for killing root-suckers and coppice shoots are described.

443 FUNGI AND BACTERIA

Quraishi, M. A., and Jamal, S. M. 1969. FUNGI ON POPULUS CILIATA WALL. IN WEST PAKISTAN. Pakistan J. For. 19 (4): 429-41. [10 refs.]

443.3

Bakshi, B. K., Ram Reddy, M. A., et al. 1970. DISEASE SITUATION IN INDIAN FORESTS. 1. STEM DISEASES OF SOME EXOTICS DUE TO CORTICIUM SALMONICOLOR AND MONOCHAETIA UNICORNIS. Indian For. 96 (11): 826-9 + 2 plates. [6 refs.]
Describes and illustrates the symptoms of attack and fungal stages observed on infected trees, predisposing factors and control measures.

Boullard, B. 1973. [DUTCH ELM DISEASE.] Foret Privee Francaise No. 89, 69-74 [F., 6 ref.]
A review, based largely on recent British literature of the origin and spread of the disease caused by Ceratocystis ulmi, describing the distribution of the fungus by bark beetles (Scolytus multistriatus in the USA and S. scolytus in Europe), the symptoms of attack, the course of the disease, the relative susceptibility of American, European and Asiatic Elms (only the latter showing any real resistance) and control measures.

Byrom, N. A., and Burdekin, D. A. 1970. BRITISH RECORDS. 101. Trans. Brit. Mycol. Soc. 54 (1): 139-41. [8 refs. O.B.D.]
Drepanopeziza punctiformis, the perfect state of Marssonina brunnea, was found in 1968 on fresh material of Populus 'Casale 78', and its identity was confirmed by laboratory experiments. In summer 1967, macroconidia of M. brunnea were observed on this clone at the Forest Research Station, Alice Holt, Surrey. This is the first record of D. punctiformis in the U.K.

Lange, A. de. 1968. PATHOGENESIS OF APLANOBACTER POPULI IN CUTTINGS AND EXPLANTS OF POPULUS CANDICANS. Meded. Phytopath. Lab. Scholten No. 70, (9-71 + 11 plates). [3 pp. of refs. [E.e.du.].]

Moriondo, F. 1973. OBSERVATIONS ON THE BIOLOGICAL CYCLE OF POPLAR RUST (MELAMPSORA SP.) [ON POPULUS CANESCENS] IN ITALY. Wellington, New Zealand, NZ Forest Service. 9 pp. + 4 fig., 2 tab. [E., Transl. from Italia Forestale e Montana (1954) 9, 259-264.]

45 DAMAGE BY ANIMALS

453 INSECTS

Habib, R., and Ghani, M. A. 1970. ERIOSOMATINAE ON POPLARS AND THEIR NATURAL ENEMIES IN WEST PAKISTAN. Technical Bulletin, Commonwealth Institute of Biological Control No. 13, 43-58 [E., 14 ref.]
Describes the 8 species of Eriosomatinae that attack Populus spp. in Pakistan.

Jodal, I. 1968. [STUDY ON DAMAGE BY THE LEAFMINER PHYLLOCNISTIS SUFFUSELLA ON POPLARS.] Topola, Beograd 12 (69/70): 23-30. [6 refs. [Serb.e.e.].]
Studies in Jugoslavian nurseries showed that attack varied with the year, with the varieties and clones, and with the type of planting stock being raised.

Webb, D. V. V. 1964. PRELIMINARY INVESTIGATIONS ON THE BIOLOGY, ECOLOGY AND CONTROL OF THE EMPEROR MOTHS, NUDAURELIA CYTHEREA CAPENSIS, STOLL., AND GONIMBRASIA TYRRHEA, CR., ATTACKING TREES AND SHRUBS IN THE WESTERN AND SOUTH-WESTERN CAPE PROVINCE. Technical Communication, Department of Agricultural Technical Services, Pretoria No. 12, (44-51). 6 refs. I.I.E.

5 FOREST MENSURATION

52 MEASUREMENTS OF STEM DIMENSIONS AND VOLUME OF TREES, STANDS, FORESTS AND TIMBER

524.3

Curro, P., and Ghisi, G. 1967. [THE APPLICATION OF MULTIPLE REGRESSIONS TO VOLUME TABLES.] Ital. for. mont. 22 (5): 223-35. [5 refs. [It.it.f.].]
Describes a technique for constructing a double-entry volume table (d.b.h. and merchantable height) for Poplar, using a multiple regression.

56 INCREMENT; DEVELOPMENT AND STRUCTURE OF STANDS

Prevosto, M. 1969. [INCREMENTS AND YIELDS OF THE TYPES OF POPLAR MORE COMMONLY GROWN IN THE LOMBARDY-PIEDMONT PLAIN.] Pubblicazione dell' Ente Nazionale per la Cellulosa e per la Carta, Roma, pp. xii + 277 + 1 map. [It.f.e.g., 14 refs.]
A further detailed and fully documented report of a study, amplifying that previously published on Populus 'I-214' [cf. F.A. 27 No. 574], in which the growth and yield of P. 'I-214' in this area

vere compared with those of P. 'I-488' and of the Poplar types P. Canadese' and P. 'Caroliniano', the forms of which grown in N. taly show little variability.

561 INCREMENT IN HEIGHT, ETC.

.aar, A. van. 1968. A STUDY OF THE GROWTH BEHAVIOUR)F POPULUS CANESCENS AND POPULUS DELTOIDES IN S.W. CAPE PROVINCE OF SOUTH AFRICA. Ned. Bosb. Tijdschr. 40 (6): 242-55. [6 refs. [E.e.du.].]
Measurements of radial growth, by dial-gauge dendrometers and Fritts dendrographs, were made in 1964-65 to 1966-67; results are shown in graphs.

8 FOREST PRODUCTS AND THEIR UTILIZATION

81 WOOD AND BARK: STRUCTURE AND PROPERTIES

812 PHYSICAL AND MECHANICAL PROPERTIES

Ghelmeziu, N. 1967. [STRUCTURE AND PHYSICAL-MECHANICAL PROPERTIES OF THE WOOD OF SOME FAST-GROWING POPLARS GROWN IN RUMANIA.] Holztechnol., Dresden 8 (4): 253-8. [26 refs. [G.g.ru.e.] P.R.]
Presents research results on: (1) % of coloured wood, and the effect of pruning thereon and on tension-wood formation; (2) fibre dimensions; and (3) density, shrinkage, elasticity, strength and hardness of (a) Populus 'Robusta', (b) P. 'Marilandica', (c) P. 'Celei', (d) P. 'Serotina', (e) P. 'Grandis', and (f) P. deltoides 'Virginiana'.

83 TIMBER MANUFACTURING INDUSTRIES AND PRODUCTS

835 INDUSTRIAL AND DOMESTIC WOODWARE (MANUFACTURE AND USE)

Sharma, S. N., and Gupta, P. G. 1972. TRIALS ON SOME HILL-GROWING HARDWOODS FOR PENCIL MAKING. Journal of the Timber Development Association of India 18 (3): 25-33 + 2 pl. [E., 5 ref. PR]
Describes factory trials on the use of Aesculus indica and Populus ciliata for pencil making. After suitable dyeing and waxing treatment, A. indica yielded high-quality pencils comparable to those made, from Cedrus deodara. P. ciliata could be used for pencils of lower quality.

86 PULP INDUSTRIES

861 PULP AND PAPER MANUFACTURE. TEXTILE AND OTHER CELLULOSE DERIVATIVES

Chawla, J. S., Sharma, A., and Krishnaswami, S. P. 1967. HIGH ALPHA CELLULOSE PULP FROM POPLAR. Indian Pulp Pap. 22 (4): 263-5. [8 refs. N.L.L.]
Data from laboratory experiments on sulphate pulping of (a) Populus ciliata and (b) P. nigra from Jammu and Kashmir show that (b) gave a higher yield of unbleached pulp, with better delignification, than (a), and that it also gave pulp with a higher α-cellulose content ((a) 71·2%, (b) 92·8%).

Guha, S. R. D., Mathur, G. M., and Sharma, Y. K. 1966. PILOT PLANT PRODUCTION OF WRITING AND PRINTING PAPERS FROM POPULUS CILIATA WALL. (POPLAR). Indian Pulp and Paper, Calcutta 21 (4): 279, 286 + 1 sample sheet. [1 ref. L.T.P.]
Satisfactory yields of both bleached and unbleached sulphate pulp were obtained from P. ciliata from Kulu (N. India), and writing paper with satisfactory strength properties was made.

Guha, S. R. D., Sharma, Y. K., and Kumar, K. 1973. PULPING OF POPLARS. Indian Forester 99 (5): 296-301 [E., 2 ref.]
Data obtained in a study of the fibre dimensions and pulping properties of Populus deltoides 'IC', P. 'I-488' and P' 'Heidemij' digested by the sulphate process indicated that the pulping properties were generally superior to those of P. ciliata and Dendrocalamus strictus. From a silvicultural point of view, P. deltoides 'IC' appears to be the most promising clone for large-scale propagation.

P. DELTOIDES TO P. GENEROSA

0 GENERAL

Burns, E. 1971. PLANTATIONS IN THE SOUTH; LAND MANAGERS TURN TO COTTONWOOD. Forests and People 21 (3): 30-32, 34-35.

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

11 SITE FACTORS: CLIMATE, SITUATION, SOIL, HYDROLOGY

114 SOIL. SOIL SCIENCE

Broadfoot, W. M., Blackmon, B. G., and Baker, J. B. 1971. SOIL MANAGEMENT FOR HARDWOOD PRODUCTION. Southeastern Hardwoods Symp. Proc., September 15-16, 1971. Dothan, Ala., pp. 17-29. USDA Forest Serv. Southeast. Area, State and Priv. For., Atlanta, Ga.

Youngberg, C. T., and Davey, C. B. [Editors]. 1971. TREE GROWTH AND FOREST SOILS. PROCEEDINGS OF THE 3RD NORTH AMERICAN FOREST SOILS CONFERENCE HELD AT NORTH CAROLINA STATE UNIVERSITY AT RALEIGH IN AUGUST 1968. Oregon State University Press, Corvallis. pp. xv + 527. [Many refs. Price $10.]
Includes, in addition to papers already noticed, or noticed elsewhere in this number: relationships between foliage nutrient levels and growth of young natural stands of Populus deltoides (E. H. White and M. C. Carter; 25 refs.) [cf. F.A. 32 No. 2187].

114.54

Merrifield, R. G. 1972. FERTILIZATION REVIEW – EASTERN COTTONWOOD. Agricultural Experiment Station, S. Coop. Ser. Bull. 158: 60-68.

114.6

Gochenaur, S. E. 1964. THE SOIL MICROFUNGI OF WILLOW-COTTONWOOD FORESTS IN SOUTHERN WISCONSIN. Abstr. of thesis, in Dissert. Abstr. 25 (3): 1514-5. O.R.S.

Discusses results of a survey from (a) five Salix nigra/Populus deltoides forests, with soils varying from melanized gley to almost pure sand, and (b) five S. interior areas, with uniformly sandy soils, averaging less than 1% organic matter and moisture.

Gochenaur, S. E., and Backus, M. P. 1967. MYCOECOLOGY OF WILLOW AND COTTONWOOD LOWLAND COMMUNITIES IN SOUTHERN WISCONSIN. II. SOIL MICROFUNGI IN THE SANDBAR WILLOW [SALIX INTERIOR] STANDS. Mycologia 59 (5): 893-901. [21 refs. O.R.S.]

116 HYDROLOGY. WATER CONSERVATION, SOIL CONSERVATION AND EROSION

Juldasev, A. Ju. 1968. [SOME FEATURES OF THE GROWTH OF TURANGA POPLAR [POPULUS SUBGEN. TURANGA] IN THE MOVING SANDS OF CENTRAL FERGHANA.] Uzbekskij Biologiceskij Zurnal, Taskent (5), (48-50). [[Ru.uzb.e.] From abstr. in Referat. Z., Moskva (6.56.214). [Ru.] N.L.L.]
The Poplar forms a few pure [natural] groves in these sands of Soviet Central Asia. When felled, it coppices and forms a bush. On the dunes, the one-year coppice shoots average 184·6 cm. long, and bush crown diam. averages 194·4 cm. In the depressions between the dunes, the Poplar coppice grows much more poorly, one-year shoots averaging only 29·64 cm. Growing bush-type coppice is an effective way of stabilizing the sands.

16 GENERAL BOTANY

160 PLANT CHEMISTRY

Broadfoot, W. M., and Farmer, R. E., Jr. 1969. GENOTYPE AND MOISTURE SUPPLY INFLUENCE NUTRIENT CONTENT OF EASTERN COTTONWOOD FOLIAGE. For. Sci. 15 (1): 46-8. [4 refs.]
In a study on potted cuttings of 30 clones of Populus deltoides in Mississippi, N, P and K contents of the foliage varied significantly between clones. Foliar N and P concentrations were significantly affected by soil moisture stress (induced by infrequent watering). Fast-growing clones usually contained lower proportions of foliar N.

Sagisaka, S. 1972. DECREASE OF GLUCOSE 6-PHOSPHATE AND 6-PHOSPHOGLUCONATE DEHYDROGENASE ACTIVITIES IN THE XYLEM OF POPULUS GELRICA ON BUDDING. Plant Physiology 50 (6): 750-755 [E., 21 ref. OBD]

Sagisaka, S. 1974. EFFECT OF LOW TEMPERATURE ON AMINO ACID METABOLISM IN WINTERING POPLAR. Plant Physiology 53 (2): 319-322 [E., 8 ref. OBD]
Analyses of free amino acids were made in 1- and 5-year-old plants of Populus 'Gelrica' throughout one year.

Tatsumi, S. 1974. [FUNDAMENTAL STUDIES OF THE CHEMICAL FORMS OF CALCIUM AND THEIR METABOLISM IN TREE LEAVES.] Mem. Fac. Agric. Kagawa Univ. 27, 67 p. [Jap.e.]

160.2

Gordon, J. C. 1971. CHANGES IN TOTAL NITROGEN, SOLUBLE PROTEIN, AND PEROXIDASES IN THE EXPANDING LEAF ZONE OF EASTERN COTTONWOOD. Plant Physiol. 47 (5): 595-9. [21 ref. OBD]
N content and soluble protein and anodul peroxidase banding in acrylamide gel changed with leaf and internode development in the expanding leaf zone of Populus deltoides.

160.21

Zvara, J., and Jurga, L. 1966. [THE DETERMINATION OF K IN PLANT MATERIAL BY MEANS OF THE FLAME PHOTOMETER WITHOUT MINERALIZATION.] Biologia, Bratislava 21 (1): 54-6. [4 refs. [Slovak.slovak.ru.g.] 1 tbl.]
Describes laboratory analyses on leaves of 10 plants, including Populus deltoides var. monilifera.

160.22

Singh, H., Kapoor, V. K., and Chawla, A. S. 1969. SOME ASPECTS OF THE RECENT ADVANCES IN PLANT STEROIDS'. J. sci. industr. Res. India 28 (9): 339-54. [264 refs. P.O.]
A review. The isolation of cholesterol from Populus fremontii pollen and Pinus banksiana and P. taeda barks, and of ecdysterone and ponasterone from Podocarpus and Taxus spp. is discussed.

161 PHYSIOLOGY

Curtis, J. D., and Lersten, N. R. 1974. MORPHOLOGY, SEASONAL VARIATION, AND FUNCTION OF RESIN GLANDS ON BUDS AND LEAVES OF POPULUS DELTOIDES (SALICACEAE). American Journal of Botany 61 (8): 835-845 [E., 19 ref. OBD]
From field observations and laboratory feeding experiments with Chrysomela scripta and a species of Aphis, it appears that the resin functions mainly as an insect repellent. It may also reduce water loss from young leaves.

Dickmann, D. I. 1971. CHLOROPHYLL, RIBULOSE-1, 5-DIPHOSPHATE CARBOXYLASE, AND HILL REACTION ACTIVITY IN DEVELOPING LEAVES OF POPULUS DELTOIDES. Plant Physiol. 48 (2): 143-5. [19 ref. OBD]
Selected biochemical factors associated with photosynthesis were investigated in expanding leaves of young P. deltoides. The study shows the importance of chlorophyll a and Calvin-cycle enzyme synthesis to photosynthetic development in expanding leaves.

Dickmann, D. I. 1971. PHOTOSYNTHESIS AND RESPIRATION BY DEVELOPING LEAVES OF COTTONWOOD (POPULUS DELTOIDES BARTR.). Botanical Gazette 132 (4): 253-259 [E., 16 ref. OBD]
Rates of photosynthesis and respiration in developing leaves of P. deltoides, in the seventh, tenth and thirteenth positions from the stem base were followed over their 17-day maturation period (plastochrome ages 0-7), by monitoring CO_2 concentrations with an infra-red gas analyser.

Dickmann, D. I., and Gjerstad, D. H. 1973. APPLICATION TO WOODY PLANTS OF A RAPID METHOD FOR DETERMINING LEAF CO_2 COMPENSATION CONCENTRATIONS. Can. J. For. Res. 3 (2): 237-242.

Dickson, R. E. 1972. THE TRANSLOCATION OF LABELLED AMINO ACIDS FROM COTTONWOOD LEAVES FED $^{14}CO_2$. [Abstract]. Plant Physiology 49 (Supplement) 23 [E., OBD]
The distribution of soluble amino acids in the leaves and stems of Populus deltoides plants showed that in older plants the labelled amino acids appeared to be translocated up or down the stems with the sugars, since the amino-acid/sugar ratio remained constant with increasing distance from the source leaf. In contrast, an increase in this ratio was found in young plants, indicating that amino acids might be moving down the stems more rapidly than the sugars. Within the source leaf a large number of amino acids were labelled, but > 90% of the C^{14} was contained in seven amino acids and, of these, glutamine, serine or alanine could contain up to 50% of the C^{14}, depending on the individual plant.

Farmer, R. E., Jr. 1964. SEX RATIO AND SEX-RELATED CHARACTERISTICS IN EASTERN COTTONWOOD. Silvae Genet. 13 (4): 116-8. 9 refs. [E.e.f.g.]
In a statistically controlled study of 551 flowering trees in 10 natural Populus deltoides stands in the lower Mississippi valley, 54% were ♂. These were significantly taller though not significantly larger in diameter than ♀s. No relation was found between sex and form class, stem straightness, branchiness or sp. gr.

Farmer, R. E., Jr. 1969. TRANSPIRATION AND LEAF TEMPERATURE IN EASTERN COTTONWOOD. For. Sci. 15 (2): 151-3. [9 refs.]
In summer at midday in central Mississippi, the leaves of potted Populus deltoides transpiring at rates of 10 X 10^{-6} to 16 X 10^{-6} g./sq.cm./sec. were cooler, but those transpiring at rates of < 4 X 10^{-6} g./sq.cm./sec. were warmer, than the surrounding air. The degree of transpirational cooling was negatively correlated with internal water deficit.

Glerum, C., and Krencigłowa, E. M. 1970. THE DEPENDENCE OF ELECTRICAL IMPEDANCE OF WOODY STEMS ON VARIOUS FREQUENCIES AND TISSUES. Canad. J. Bot. 48 (12): 2187-92. [10 ref. ORS]
Electrical impedance was determined over a range of frequencies in sets of 10 twigs of the current year's growth of Picea glauca, Pinus resinosa, Larix laricina, Populus deltoides, Betula papyrifera and Acer saccharinum before and after boiling in water for 30 seconds.

lerum, C., and Zazula, R. 1973. INFLUENCE OF VARIOUS LECTRODES AND TISSUES ON THE ELECTRICAL MPEDANCE OF WOODY STEMS. Canadian Journal of Plant cience 53 (2): 385-389 [E.f., 9 ref. ORE]
our-electrode probes of stainless steel, Ni-plated steel, Ag, or loridized Ag were equally effective when tested on current-year vigs of Pinus resinosa or Populus deltoides, showing that contact sistance was negligible.

ernandez-Gil, R., and Schaedle, M. 1972. PHOTOPHOSPHO-YLATION AND CARBON DIOXIDE FIXATION BY CHLORO-LASTS ISOLATED FROM POPULUS DELTOIDES. Plant ysiology 50 (3): 375-377 [E., 16 ref. OBD]
escribes a system by which photosynthetically active chloroplasts ould be isolated from leaves of Populus deltoides.

ernandez-Gil, R., and Schaedle, M. 1973. FUNCTIONAL AND TRUCTURAL CHANGES IN SENESCING POPULUS ELTOIDES (BARTR.) CHLOROPLASTS. Plant Physiology 1 (2): 245-249 [E., 27 ref. OBD]
hloroplasts were isolated and it was shown that their ability to nthesize ATP diminished steadily from the time of full leaf pansion, in parallel with a decrease in the rate of CO_2 fixation. It suggested that the efficiency of the membrane-bound ATP-nthesizing system declines with age.

ook, D. D., and Brown, C. L. 1972. PERMEABILITY OF THE AMBIUM TO AIR IN TREES ADAPTED TO WET HABITATS. otanical Gazette 133 (3): 304-310 [E., 8 ref. OBD]
he amount of tension needed to pull across the cambium of Nyssa quatica and Fraxinus pennsylvanica is low enough to permit free s exchange with the atmosphere, but that air movement across the mbia of Liquidambar styraciflua. Liriodendron tulipifera and latanus occidentalis is restricted. N. aquatica and F. pennsylvanica ossess significant intercellular spaces among the cambial ray itials, giving an open interconnecting aeration system between the ylem and the phloem rays on either side. Similar openings in the mbium are absent or (1 µm in size in the other three species and Populus deltoides.

ebrands, J. G., and Larson, P. R. 1973. ANATOMICAL HANGES DURING LEAF ONTOGENY IN POPULUS ELTOIDES. American Journal of Botany 60 (3): 199-208 [E., 42 f. OBD]

eremias, K. 1969. [WINTER ACCUMULATION OF SUGARS IN HE VEGETATIVE PARTS OF PLANTS.] Ber. Dtsch. Bot. Ges. 2 (1/2): 87-97. [18 refs. [G.] O.B.D.]
ncludes data for the yearly course of sugar accumulation in needles f Sequoia gigantea, bark and wood of Picea abies, bark of Populus Oxford', and bark of Euonymus europaeus.

arson, P. R., and Dickson, R. E. 1973. DISTRIBUTION OF IPORTED ^{14}C IN DEVELOPING LEAVES OF EASTERN OTTONWOOD ACCORDING TO PHYLLOTAXY. Planta 111 (2) 5-186 [E., 34 ref. OBD]
dividual leaves of young Populus deltoides plants of similar age ere allowed to assimilate $C^{14}O_2$ and were harvested 2-24 hours ter; the leaves represented an ontogenetic series with leaf astochron indices (LPI) from 3 to 8. Uptake of C^{14} (by anslocation of assimilate) was greatest in leaves of LPI 1-3, respective of the age of the source leaf. C^{14} was translocated eferentially to either the left or right half of the lamina, pending on the position of the importing leaf in the phyllotactic quence and its stage of development. Within an 8-leaf growth unit ^{14} import was high when the importing leaf and the source leaf d two vascular bundles in common, and declined as the number of ndles in common decreased.

arson, P. R., and Gordon, J. C. 1969. LEAF DEVELOPMENT, HOTOSYNTHESIS, AND C^{14} DISTRIBUTION IN POPULUS ELTOIDES SEEDLINGS. Amer. J. Bot. 56 (9): 1058-66. [19 refs. .B.D.]
tes of net photosynthesis and dark respiration and the distribu-on of C^{14} from selected leaves were determined on young P. ltoides at different stages of development.

arson, P. R., Isebrands, J. G., and Dickson, R. E. 1972. FIXATION ATTERNS OF C^{14} WITHIN DEVELOPING LEAVES OF EASTERN COTTONWOOD. Planta 107 (4): 310-314 [E., 16 ref. OBD]
Describes experiments with individual leaves of Populus deltoides.

Molotkovskij, Ju. I. 1969. [TRANSPIRATION RATE OF POPULUS PRUINOSA IN THE RIPARIAN WOODLANDS OF THE TIGROVAJA BALKA RESERVE.] Dokl. Akad. Nauk TadzSSR 12 (7): 66-9. [Ru.tadzhik From abstr. in Referat. Z. 1970 (5.56.90). Ru. N.L.L.]
Transpiration rate was determined at intervals from spring to September in two years, by the rapid-weighing technique, on a site in Tadzhikistan where the roots always had access to groundwater.

Naidenova-Yañeva, T. 1973. [SEASONAL PATTERN OF THE WATER REGIME OF LEAVES OF POPULUS DELTOIDES.] Gorskostopanska Nauka 10 (1): 13-33 [Bulg.ru.e., 23 ref.]
Gives results of experiments in which 1-year plants were grown in pots where soil moisture was kept at 25, 40, 55, 70, 85, or 100% of maximum water-holding capacity.

Neuwirth, G., and Fritzsche, K. 1964. [THE EFFECT OF VARYING THE AMOUNT OF FERTILIZER ON THE ECOLOGICALLY CONDITIONED GAS EXCHANGE IN ONE-YEAR SHOOTS FROM CUTTINGS OF POPULUS X CANADENSIS CV. 'FORNDORF'.] Arch. Forstw. 13 (3): 233-46. 15 refs. [G.g.ru.e.]
Both transpiration and assimilation are shown to be specifically affected by different amounts of fertilizer, transpiration reacting to these more strongly than assimilation.

Sagisaka, S. 1968. STUDIES ON CRYOBIOCHEMISTRY IN PLANTS. I. METABOLISM OF RIBOSE 5-PHOSPHATE IN POPULUS GELRICA. Low Temperature Science, Hokkaido (Ser. B) No. 26, (33-43). [Jap.e.]
Gives the results of a study of some properties of cell-free preparations, with special reference to ribose 5-phosphate metabolism in winter and summer.

Sagisaka, S. 1970. [STUDIES ON CRYOBIOCHEMISTRY IN PLANTS. VII. SUGAR-PHOSPHATE LEVELS IN BARK AND XYLEM AND ITS RELATION TO LIFE PROCESS IN POPULUS GELRICA.] Teion Kagaku Seibutsu Hen Low Temp Sci. Ser. B Biol. Sci. 28 (45): 37-42. [Jap.e.]

Sagisaka, S. 1970. [STUDIES ON CRYOBIOCHEMISTRY IN PLANTS. VIII. SHIFT OF WINTER TYPE METABOLISM AND DISSIMILATION ACTIVITY IN POPULUS GELRICA.] Teion Kagaku Seibutsu Hen Low Temp Sci. Ser. B Biol. Sci. 28 (45): 49. [Jap.e.]

Wodzicki, T. J., and Brown, C. L. 1970. ROLE OF XYLEM PARENCHYMA IN MAINTAINING THE WATER BALANCE OF TREES. Acta Soc. Bot. Polon 39 (3): 617-22. [E.pol., 7 refs. O.B.D.]
In comparisons of uptake and evaporation of water in stem segments of 2-year-old Platanus occidentalis, Pinus densiflora, one-year-old Populus deltoides, and three-year-old Fraxinus americana, immersed in water at their basal end, but having different initial degrees of dehydration, significantly greater amounts of water were taken up and accumulated by all the live segments during the first 24 hours, and significant differences were maintained after 48 hours, though during the latter 24 hours the rate of water uptake decreased in both dead and live stems. Evaporation was greater from the cut surfaces of live than from dead segments of the broadleaved species.

161.4

Larson, P. R., and Isebrands, J. G. 1971. THE PLASTOCHRON INDEX AS APPLIED TO DEVELOPMENTAL STUDIES OF COTTONWOOD. Canad. J. For. Res. 1 (1): 1-11. [E.f., 14 ref.]

163 EMBRYOLOGY

Kots, Z. P. 1972. [DEVELOPMENT OF THE FEMALE FLOWER OF POPULUS PRUINOSA (SUBGEN. TURANGA).] Ukrains'kii Botanichnii Zhurnal 29 (2): 228-232 [Uk.e., 4 ref. APB]

164 MORPHOLOGY

Aytug, B. 1969. [CONTRIBUTIONS OF POLLEN MORPHOLOGY TO TAXONOMY.] Istanbul Univ. Orm. Fak. Derg. 19A (1): 131-42. [F.tr., 1 ref.]

Avanzo, E. 1967. [BIOMETRICAL STUDIES OF THE FLOWER BUDS OF AN ANDROGYNOUS INDIVIDUAL OF POPULUS DELTOIDES.] Proc. 14th Congr. Int. Union For. Res. Organ., Munich, Pt. III, Sect. 22, (72-6). [F.]

Chardenon, J. 1972. [NUMBER OF STAMENS PER FLOWER, ACCORDING TO THE POSITION OF THE FLOWER IN THE CATKIN.] Bulletin du Service de Culture et d'Etudes du Peuplier et du Saule 16 [F.]
Presents a graph showing the number of stamens per flower for all the flowers in two ♂ catkins of Populus deltoides '42-4', and notes that the number of stamens is practically constant from the fifth to the twentieth flower from the base of the catkin, but decreases progressively thereafter.

Curtis, J. D. 1972. THE ANATOMY OF COTTONWOOD (POPULUS DELTOIDES) VEGETATIVE BUDS. [Abstract]. American Journal of Botany 59 (6, Part 2) 649 [E., OBD]
Presents a study of the morphology and anatomy of the immature leaves within the bud, with particular reference to the secretory cells of the stipules and their function as producers of protective resin.

Curtis, J. D. 1973. FINE STRUCTURE OF SECRETORY CELLS OF POPULUS DELTOIDES. [Abstract]. American Journal of Botany 60 (4): 5-6 [E., OBD]
Describes the composition of the cytoplasm of the secretory cells of leaf serrations and the adaxial surface of the stipule, and speculates on the mode of production of the resinous secretion and its release to the leaf surface, where it forms a protective film over young leaves.

Curtis, J. D. 1974. MORPHOLOGY, SEASONAL VARIATION, FINE STRUCTURE AND FUNCTION OF RESIN GLANDS ON BUDS AND LEAVES OF POPULUS DELTOIDES (SALICACEAE). [Abstract]. Dissertation Abstracts International, B 34 (10): 4852 [E., Order No. 74-9109.]

Curtis, J. D., and Lersten, N. R. 1973. GLAND STRUCTURE AND FUNCTION IN POPULUS DELTOIDES. [Abstract]. American Journal of Botany 60 (4): 6 [E., OBD]

165 PHYLOGENY, EVOLUTION. HEREDITY, GENETICS AND BREEDING, VARIATION

Bridgewater, F. E. 1972. SELECTION INDICES FOR EASTERN COTTONWOOD. Ph. D. Thesis, Oklahoma State University, Department of Agronomy.

Eldridge, K. G. 1971. VARIATION IN POPULUS DELTOIDES. Pap. to Aust. Plt. Breeding Conf., Perth.

Farmer, R. E., Jr., and Nance, W. L. 1967. CROSSING EASTERN COTTONWOOD IN THE GREENHOUSE. Repr. from Proc. Pl. Propag. Soc. 17, (333-8). [12 refs. 1 fig.]
Describes controlled crossing techniques used in the Lower Mississippi Valley.

Guzina, V. 1974/1975. [GENETIC POLYMORPHISM OF THE ISOENZYMES OF PEROXIDASE AND ESTERASE IN POPULUS DELTOIDES.] Topola 18/19 (103/106): 170-176. [Sh.e.ru., 22 ref.]
Reports the frequency of occurrence of 6 isoperoxidases and 2 isoesterases in the leaves of 34 half-sib families, from 11 States of the USA, grown at Novi Sad, Yugoslavia.

Houston, D. B. 1973. CLONAL SELECTION OF COTTONWOOD. Ohio, Agricultural Research and Development Center. Res. Summ. Ohio Agric. Res. Dev. Cent. 70: 9-11.

Miller, L. G. 1972. THE CONTROLLED POLLINATION OF EASTERN COTTONWOOD IN THE GREENHOUSE. M.S. Thesis, Oklahoma State University, Department of Forestry.

Muller, R. 1968. [POPULUS X GENEROSA – PHENOMENON OR PHANTOM? P. ANGULATE – A GROUP OF HETEROGENEOUS CLONES?] Silvae Genet. 17 (2/3): 93-106. [22 refs. [G.g.f.e.].]

Ying, C. C. 1974. GENETIC VARIATION OF EASTERN COTTONWOOD (POPULUS DELTOIDES BARTR.) Lincoln, NE., University of Nebr. 1974. 148 pp. (Ph. D. dissertation)
Describes a study of variation in trees of a provenance trial established in Nebraska in 1966, with 498 clones of 116 open-pollinated families from major parts of the range of P. deltoides, which revealed clinal variation . . .

165.3/.7

Anonymous. 1968. [NEW POPLAR CLONE.] Extr. from Rep. For. Res. Inst. Dep. For. S. Afr. 1967/68, (21).

Anonymous. 1969. FOREST BOTANY. Extr. from Rep. Dep. For. S. Afr. 1967/68, (86, 87). [Afr.E.]

Avanzo, E. 1969. HEIGHT GROWTH OF POPULUS DELTOIDES MARSH. IN NURSERY, ACCORDING TO LATITUDE OF ORIGIN. [Pap.] 2nd FAO/IUFRO World Consult. For. Tree Breed., Washington 1969 No. FO-FTB-69-2/13, pp. [6]. [E.e.]

Besschetnov, P. P., and Grudzinskaya, L. M. 1974. [EFFECT OF ECOLOGICAL FACTORS ON THE VARIATION OF MORPHOLOGICAL CHARACTERS OF POPULUS PRUINOSA.] Ekologiya No. 6, 37-40 [Ru., 13 ref. BLL]
Tabulates data on the morphological characters of male and female trees in two natural populations of P. pruinosa in Kazakhstan, one growing in optimum conditions (a floodplain terrace, water table not deeper than 1.5 m), the other in a solonchak plain (water table 3-4 m).

Bridgewater, F. E., Jr. 1973. MULTIPLE TRAIT SELECTION IN A POPULATION OF EASTERN COTTONWOOD. [Abstract]. Dissertation Abstracts International, B 33 (12): 5596 [E., Order No. 73-15,057. ORS]
A study was made to determine how selection should be performed to achieve the greatest genetic improvement in Populus deltoides in Oklahoma. Comparisons of clones planted at two locations were used to assess the magnitude and type of genotype X environment interactions for several economically important traits.

Cooper, D. T., and Randall, W. K. 1973. GENETIC DIFFERENCES IN HEIGHT GROWTH AND SURVIVAL OF COTTONWOOD FULL-SIB FAMILIES. In Proceedings, 12th Southern Forest Tree Improvement Conference. 206-212 [E., 4 ref.]
Reports an evaluation of 1-year-old clonal plants raised from cuttings taken from seedlings representing crosses between four fast-growing female and four fast-growing male clones of Populus deltoides. Ca. 70% of the genetic variance in height, but only 18% of that for survival, was additive.

Curlin, J. W. 1967. CLONAL DIFFERENCES IN YIELD RESPONSE OF POPULUS DELTOIDES TO NITROGEN FERTILIZATION. Proc. Soil Sci. Soc. Amer. 31 (2): 276-80. [8 refs.]
Trees propagated from cuttings of 22 P. deltoides clones were grown (a) unfertilized and (b) fertilized with NH_4NO_3. Mean diameter and height of the clonal populations were more than doubled by (b). A strong clone/fertilizer interaction was observed for diam., height, and vol. growth. Wood sp.gr. was reduced by (b), but no interaction between clones and fertilizers was noted for that character after 2 years.

Farmer, R. E., Jr. 1970. GENETIC VARIATION AMONG OPEN-POLLINATED PROGENY OF EASTERN COTTONWOOD. Silvae Genet. 19 (5/6): 149-51. [E., 7 refs.]

Farmer, R. E., Jr. 1970. VARIATION AND INHERITANCE OF EASTERN COTTONWOOD GROWTH AND WOOD PROPERTIES UNDER TWO SOIL-MOISTURE REGIMES. Silvae Genet. 19 (1): 5-8. [E., 12 refs.]
A pot study was made of genetic variation in 30 Populus deltoides clones grown under two moisture regimes, (a) watering daily or twice daily, and (b) watering individually after incipient wilt of the apex.

Farmer, R. E., Jr., and Wilcox, J. R. 1964. COTTONWOOD IMPROVEMENT SYSTEM FOR COMMERCIAL PLANTERS. U.S. For. Serv. Res. Note Sth. For. Exp. Sta. No. SO-7, pp. 3. 2 refs.
Describes the selection, propagation, and testing of superior clones of Populus deltoides in Mississippi. Plantations should be mixtures of clones, since a selected clone may prove susceptible to a particular pest.

Farmer, R. E., Jr., and Wilcox, J. R. 1968. PRELIMINARY TESTING OF EASTERN COTTONWOOD CLONES. Theoret. appl.

Genet., Berl. 38 (5): 197-201. [16 refs. [E.e.g.] E.M.B.]
In a study of a population of 100 clones of Populus deltoides from central Mississippi, planted as unrooted cuttings in Feb. 1964 and grown for one year on Commerce loam or Sharkey clay, the following broad-sense heritabilities were obtained: height 0·44-0·47, diam. 0·24-0·28; volume 0·26-0·29; wood sp.gr. 0·69-0·70; fibre length 0·36; and resistance to Melampsora rust 0·83-0·89.

Illies, Z. M. 1969. SQUASH METHODS FOR CYTOLOGICAL INVESTIGATIONS IN POPULUS EUPHRATICA, PINUS GRIFFITHII, EUCALYPTUS CAMALDULENSIS AND ACACIA ARABICA. Pakistan Nat. For. Res. Train. Proj. Rep., Peshawar No. 4, pp. 15 + 3 figs. [5 refs.]
Develops staining and fixing schedules for preparing specimens of each of these species for chromosome investigation.

Jokela, J. J. 1964. HERITABLE VARIATION IN NATURAL POPULATIONS OF POPULUS DELTOIDES BARTR. IN ILLINOIS. Abstr. of thesis, in Dissert. Abstr. 24 (9): 3484-5. O.R.S.

Jokela, J. J., and Gray, L. E. 1967. TOPOPHYSIS IN RELATION TO PERIDERM DEVELOPMENT AND INCIDENCE OF CANKERING IN EASTERN COTTONWOOD. Proc. 5th Cent. St. For. Tree Impr. Conf., Ohio 1966, (22-5). [10 refs.]
Trees originating from cuttings taken from the upper crown of adult trees still had a light-coloured, smooth bark at 8 years of age. Possibly related to this bark difference is the greater incidence and severity of cankering observed in the seedling plantation.

Mohn, C. A., and Randall, W. K. 1969. PRELIMINARY SELECTION OF EASTERN COTTONWOOD CLONES. In Proceedings of the 10th Southern Conference on Forest Tree Improvement. 41-48 [E., 6 ref.]
Presents the results of preliminary testing for the selection of fast-growing clones of Populus deltoides at the Southern Hardwoods Laboratory of the US Southern Forest Experiment Station, and outlines techniques to be used in further clonal selections.

Mohn, C. A., and Randall, W. K. 1971. INHERITANCE AND CORRELATION OF GROWTH CHARACTERS IN POPULUS DELTOIDES. Silvae Genet. 20 (5/6): 182-4. [9 ref.]
Reports tests with cuttings of 38 clones taken at random from a population of 2-year-old naturally established seedlings. Up to 6 years of age, genetic variation accounted for 30-50% of the total variation in height, and for 20-35% of the variation in diameter.

Ohio Agric. Res. and Devel. Cent. 1973. FORESTRY RESEARCH REVIEW – 1973 [FOREST TREE IMPROVEMENT]. Research Summary, Ohio Agricultural Research and Development Center No. 70, 26 pp. [E.]
A collection of 9 papers describing 3-year results from experiments begun several years ago in Ohio, including: Clonal selection of Cottonwood [Populus deltoides] (D.B. Houston).

Posey, C. E. 1969. PHENOTYPIC AND GENOTYPIC VARIATION IN EASTERN COTTONWOOD IN THE SOUTHERN GREAT PLAINS. In Proceedings of the 10th Southern Conference on Forest Tree Improvement. 130-135 [E., 2 ref.]
Gives a preliminary account of observations on field material in part of the western limit of the range of Populus deltoides, and on plants grown from cuttings from sample trees.

Posey, C. E., Bridgwater, F. E., and Buxton, J. A. 1969. NATURAL VARIATION IN SPECIFIC GRAVITY, FIBER LENGTH, AND GROWTH RATE OF EASTERN COTTONWOOD IN THE SOUTHERN GREAT PLAINS. Tappi 52 (8): 1508-11. [15 refs.]

Randall, W. K., and Mohn, C. A. 1969. CLONE-SITE INTERACTION OF EASTERN COTTONWOOD. In Proceedings of the 10th Southern Conference on Forest Tree Improvement. 89-91 [E., 3 ref.]
Clone/site interactions in 79 Populus deltoides clones planted on a good and a poor site in Mississippi were significant for both height and diameter growth for all ages up to 3 or 4 years.

Schreiner, E. J. 1971. GENETICS OF EASTERN COTTONWOOD. US For. Serv. Res. Pap. US Dep. Agric. No. WO-11, pp. 19. [84 ref.]
Reviews information on Populus deltoides under the heads: taxonomy and range; silvics; sexual reproduction; requirements in genetic improvement; and improvement procedures.

Southern Forest Tree Impr. Committee. 1965. PROCEEDINGS OF THE EIGHTH SOUTHERN CONFERENCE ON FOREST TREE IMPROVEMENT. SAVANNAH, GEORGIA. JUNE 16-17, 1965. Georgia Forest Research Council, Macon, Georgia. pp. 161. [Many refs.]
Thirty-three papers, including (in addition to papers noticed separately): Populus deltoides in the lower Mississippi valley (R. E. Farmer, Jr.).

USDA Forest Service. 1966. JOINT PROCEEDINGS, SECOND GENETICS WORKSHOP OF THE SOCIETY OF AMERICAN FORESTERS AND THE SEVENTH LAKE STATES FOREST TREE IMPROVEMENT CONFERENCE, OCTOBER 21-23, 1965. U.S. For. Serv. Res. Pap. Nth. Cent. For. Exp. Sta. No. NC-6, pp. 110. [Many refs.]
Includes: Variation in juvenile growth and wood properties in half-sib Cottonwood families (R. E. Farmer, Jr., and J. R. Wilcox; 11 refs.)

Wilcox, J. R., and Farmer, R. E., Jr. 1967. VARIATION AND INHERITANCE OF JUVENILE CHARACTERS OF EASTERN COTTONWOOD. Silvae Genet. 16 (5/6): 162-5. [9 refs. [E.e.].]
Forty-nine randomly selected Populus deltoides clones were studied for two years in Mississippi in a replicated test to determine inherited variations. Gains from selection were predicted for several characters.

Wilcox, J. R., and Farmer, R. E., Jr. 1968. HERITABILITY AND C EFFECTS IN EARLY ROOT GROWTH OF EASTERN COTTONWOOD CUTTINGS. Heredity 23 (2): 239-45. [11 refs. O.R.S.]
Early root development of dormant Populus deltoides cuttings from 49 clones in Mississippi had a broad-sense heritability of 0·33-0·44 in a loam potting soil and 0·52-0·58 in a poorly drained clay soil. Clonal variation in rooting was strongly related to highly heritable differences in flushing date. 'C' effects (physiological or morphological characteristics unique to the ortet because of its specific environment), estimated by two-stage cloning, were large enough to be important in short-term clonal tests.

165.3

Avanzo, E. 1969. [OBSERVATIONS ON THE VARIABILITY OF ROOTING OF SEEDLINGS OF POPULUS DELTOIDES BARTR. IN NURSERY.] Cellulosa e Carta 20 (3): 25-27. [It.]

Avanzo, E. 1969. [OBSERVATIONS ON VARIATIONS IN SEED DIMENSIONS OF POPULUS DELTOIDES BARTR. IN RELATION TO LATITUDES.] Cellulosa e Carta 20 (3): 35-41. [It.]

168 HISTOLOGY

Sakai, A., and Sugawara, Y. 1973. SURVIVAL OF POPLAR CALLUS AT SUPER-LOW TEMPERATURES AFTER COLD ACCLIMATION. Plant and Cell Physiology 14: 1201-1204. [E. From Berichte Biochemie und Biologie (1975) 411, 505. De.]
Cold-hardened pieces of callus of Populus 'Gelrica' survived 2 hours' immersion in liquid N and, after slow reheating and return to 26 °, formed vigorous callus again.

17 SYSTEMATIC BOTANY

176.1 DICOTYLEDONEAE

Muller, R. 1969. [THE DROMLING POPLAR (REGENERATA OF SWITZERLAND).] Bull. Serv. Cult. Etud. Peuplier et Saule (1-10). [F.]

18 PLANT ECOLOGY

181 MODE OF LIFE, AUTECOLOGY. SILVICULTURAL CHARACTERS OF TREES

181.2

Chandler, J. W., and Thielges, B. A. 1973. CHILLING AND PHOTOPERIOD AFFECT DORMANCY OF COTTONWOOD CUTTINGS. In Proceedings, 12th Southern Forest Tree Improvement Conference. 200-205 [E., 7 ref.]
Short exposures (50-60 days) of unrooted cuttings of Populus deltoides to chilling at 1.6° C, before planting in a greenhouse under normal and extended (16-hour) photoperiods, were sufficient to

overcome any effect of extended photoperiods in breaking bud dormancy.

Ogawa, Y. 1968. [STUDIES ON SHADE TOLERANCE OF FOREST TREES BY THE METHOD OF MEASURING DAILY COMPENSATION POINT.] Bull, Kyushu Univ. For. No. 43, (213-77). [106 refs. [Jap.e.].]
A comparison is made between current methods of estimating shade tolerance (field observation and laboratory studies) and estimation by daily compensation point (DCP).

Sakai, A. 1965. [TEMPERATURE FLUCTUATIONS IN WINTERING TREES. II.] J. Jap. For. Soc. 47 (12): 444-7. 6 refs. [Jap.jap.e.e.]

Sakai, A. 1973. CHARACTERISTICS OF WINTER HARDINESS IN EXTREMELY HARDY TWIGS OF WOODY PLANTS. Plant and Cell Physiology 14 (1): 1-9. [E., 21 ref. OBD]
Describes experiments in Sapporo with twigs from trees aged 10-13 years of 13 hardy species (including Betula platyphylla, B. pubescens, Salix sachalinensis, Populus 'Gelrica', Pinus pumila, P. strobus, P. sylvestris, Abies balsamea, and Picea glauca).

Yoshida, S. 1973. [SEASONAL CHANGES IN LIPIDS AND FREEZING RESISTANCE IN POPLAR TREES.] Low Temperature Science, B 31, 9-20 [Jap.e., 27 ref. BLL]

Yoshida, S., and Sakai, A. 1973. [FREEZING INJURY AND DEGRADATION OF PHOSPHOLIPID COMPONENTS IN PLANT CELLS. I. DEGRADATION OF PHOSPHOLIPID COMPONENTS IN PLANT CELLS DURING FREEZING.] Low Temperature Science, B 31, 31-39 [Jap.e., 15 ref. BLL]
The degradation of phospholipid components in plant cells during freezing was studied in samples from the cortex of Populus 'Gelrica' and leaves of Aucuba japonica.

Yoshida, S., and Sakai, A. 1974. PHOSPHOLIPID DEGRADATION IN FROZEN PLANT CELLS ASSOCIATED WITH FREEZING INJURY. Plant Physiology 53 (3): 509-511 [E., 18 ref. OBD]
Degradation of phosphatidylcholine into phosphatidic acid was observed in the cortical tissues of current-year twigs of Populus 'Gelrica', collected in Sept. and Oct. (before winter hardiness had developed), when the tissues were frozen below a lethal temperature (-10° C).

181.3

Blackmon, B. G., and Broadfoot, W. M. 1969. LIME, FERTILIZER COTTONWOOD TESTS. Repr. from Mississippi Farm Research, State College 32 (7): 6, 8.
In Mississippi pot trials, seedlings showed response to NPK and/or Ca on (acid) Bibb sandy loam, to N on Commerce loam and no response to fertilizer on two other soils.

Bonner, F. T. 1967. RESPONSES OF 1-YEAR-OLD COTTONWOOD TO INCREASING SOIL MOISTURE TENSION. U.S. For. Serv. Res. Note Sth. For. Exp. Sta. No. SO-56, pp. 3. [2 refs.]
Transpiration rates of cuttings of Populus deltoides potted in sandy-loam or clay soils began to decrease at leaf water deficits of 2·5% in sandy loam and 4·5% in clay.

Bonner, F. T. and Broadfoot, W. M. 1967. GROWTH RESPONSE OF EASTERN COTTONWOOD TO NUTRIENTS IN SAND CULTURE. U.S. For. Serv. Res. Note Sth. For. Exp. Sta. No. SO-65, pp. 4. [9 refs.]
Seedlings of Populus deltoides grew best with nutrient solutions of 100 p.p.m. N, 75 p.p.m. P, and 100 p.p.m. K. The foliage of the largest seedlings contained 3·5-4·5% N, 0·5-0·7% P, and 3·0-4·0% K.

Broadfoot, W. M. 1973. WATER TABLE DEPTH AND GROWTH OF YOUNG COTTONWOOD. US Forest Service Research Note, Southern Forest Experiment Station No. SO-167, 4 pp. [E.]
Cuttings from a single clone of Populus deltoides were grown in containers in which the water table was maintained (a) at the soil surface, (b) 1 ft from the surface, (c) 2 ft from the surface and (d) with no water table (controls). At the end of the first growing season, height growth and root, stem, and total plant weights were in the order (a) < (d) < (b) < (c).

Foulger, A. N., Freese, F., and Shire, E. A. 1971. EFFECT OF NUTRIENT CONCENTRATION ON STEM ANATOMY OF EASTERN COTTONWOOD SEEDLINGS. Wood & Fiber 2 (4): 340-6. [16 refs.]
The effect of different concentrations and combinations of N, P, K, Ca, and Mg on fibre length, vessel length and width, and percentage of fibre, vessel and ray tissue in 1-year-old Populus deltoides seedlings (pot-grown in quartz sand) was analysed by response-surface methods.

Hilton, R. J., and Khatamian, H. 1973. DIURNAL VARIATION IN ELONGATION RATES OF ROOTS OF WOODY PLANTS. Canadian Journal of Plant Science 53 (3): 699-700 [E., 5 ref. ORE]
Time-lapse cinematography was used to record the root elongation during summer and/or autumn 1970 in a rhizotron at Guelph, Ontario.

Liani, A. 1971. [PRELIMINARY EXPERIMENTS ON APPLICATION OF PHOSPHATE FERTILIZER TO YOUNG POPLARS.] Pubbl. Cent. Sper. Agric. For. 11 (1): 55-62. [It.e., 10 ref.]
In experiments on cuttings of Populus 'I-214' and P. deltoides 'UAS-235' potted in nursery soil or variously treated sandy soil, application of NPK fertilizer gave the greatest height and weight increments in both clones.

Liphschitz, N., and Waisel, Y. 1970. THE EFFECT OF WATER STRESSES ON RADIAL GROWTH OF POPULUS EUPHRATICA OLIV. La-Yaaran 20 (3): 53-61, 84-80. [Heb.E., 23 refs.]
The effects of water stress on radial growth of P. euphratica were investigated in the field and in a controlled environment.

Liphschitz, N., and Waisel, Y. 1970. EFFECTS OF ENVIRONMENT ON RELATIONS BETWEEN EXTENSION AND CAMBIAL GROWTH OF POPULUS EUPHRATICA OLIV. New Phytol. 69 (4): 1059-64 + 2 plates). [8 refs. O.R.S.]

Naidenova-IAneva, T. 1973. [ON THE DYNAMICS OF THE WATER REGIMEN IN POPULUS DELTOIDES MARSH LEAVES.] Gorskostopanska Nauk 10 (1): 13-33. [Bulg.e.]

Turmanina, V. I. 1965. [THE STRENGTH OF TREE ROOTS.] Bjull. Mosk. Obsc. Ispyt. Prir. (Otd. Biol.) 70 (5): 36-45. 17 refs. [Ru.ru.e.] N.L.L.

Vozzo, J. A. 1969. ENDOTROPHIC MYCORRHIZAE FOUND ON POPULUS DELTOIDES. For. Sci. 15 (2): 158. [4 refs.]
P. deltoides, recorded by Fontana as ectotrophic with Lepista nuda and by Trappe as ectotrophic with Cenococcum graniforme is shown to be also endotrophic with a phycomycete, probably Endogone sp.

White, E. H. 1969. NUTRIENT AND DRY MATTER RELATIONS IN YOUNG STANDS OF POPULUS DELTOIDES BARTR. Abstr. of thesis, in Dissert. Abstr. int. 30B (3): 928-9. [Order No. 69-14,195. Price: M.$3.00; X.$5.60. pp. 112. O.R.S.]
The relations between amounts of nutrients in the soil and the tree, dry-matter production, tree height, foliage weight, stand density and site quality on alluvial sites in S.W. Alabama were studied. Tables are given for estimating tree volume, weight and nutrient content by diameter class.

White, E. H., and Carter, M. C. 1970. PROPERTIES OF ALLUVIAL SOILS SUPPORTING YOUNG STANDS OF EASTERN COTTONWOOD IN ALABAMA. U.S. For. Serv. Res. Note Sth. For. Exp. Sta. No. SO-111, pp. 4, [12 refs.]
Reports a study of the relation of stand growth to the texture, pH, and concentrations of extractable P, K, Ca and Mg to a depth of 36 in. in flood-plain soils supporting 6- to 9-year-old, pure, natural stands of Populus deltoides in S.W. Alabama.

White, E. H. 1974. WHOLE-TREE HARVESTING DEPLETES SOIL NUTRIENTS. Canadian Journal of Forest Research 4 (4): 530-535 [E.f., 23 ref.]
Reports the effects on the soil nutrient pool of whole-tree harvesting of eight Populus deltoides stands. The data indicate possible site degradation by depletion of reserves of N, P and K in the soil, but not of Ca and Mg, under a range of alluvial site conditions in Alabama.

181.5

Broekhuizen, J. T. M. 1967. [THE SEX OF POPULUS 'FLEVO'.] Ned. Bosb. Tijdschr. 39 (4): 195. [Du.]
The oldest tree produced ♂ flower buds.

rmer, R. E., Jr. 1964. COTTONWOOD FLOWERING AS ELATED TO COLD REQUIREMENT OF FLOWER BUDS. For. i. 10 (3): 296-9. 12 refs.

rmer, R. E., Jr. 1966. VARIATION IN TIME OF FLOWERING ND SEED DISPERSAL OF EASTERN COTTONWOOD IN THE)WER MISSISSIPPI VALLEY. For. Sci. 12 (3): 343-7. [7 refs.]
fferences between trees within stands accounted for 98% of the nificant variation in dates of seed dispersal and flowering. rrelations between years indicated that trees within stands flower, d probably also disperse seed, in a predictable sequence.

rmer, R. E., Jr., and Bonner, F. T. 1967. GERMINATION AND ITIAL GROWTH OF EASTERN COTTONWOOD AS FLUENCED BY MOISTURE STRESS, TEMPERATURE, AND ORAGE. Bot. Gaz. 128 (3/4): 211-5. [5 refs. O.B.D.]
rminative energy of P. deltoides seed decreased gradually as oisture stress increased; 15 atm. inhibited germinatiin except at 32 d 38° C. Temperature extremes of 15° and 38° drastically reduced rminative energy, and the reducing effect of 38° was particularly arked after storage. Germination under optimum conditions 7-32°) was reduced from 90 to 69% by 12 months' storage.

vchenko, V. A., and Kroshechkina, A. G. 1973. [FLOWERING COLOGY OF POPULUS PRUINOSA AND ELAEAGNUS NGUSTIFOLIA IN THE RIPARIAN WOODLANDS OF UTHERN TADZHIKISTAN.] Dokl. AN TadzhSSR 16 (4) 61-64 u.tadzhik] From Referativnyi Zhurnal (1973) 11.56.112. Ru. L.

181.8

szkurewicz, A., and Fogg, P. J. 1967. GROWING SEASONS OF OTTONWOOD AND SYCAMORE AS RELATED TO GEO-RAPHIC AND ENVIRONMENTAL FACTORS. Ecology 48 (5): 5-93. [35 refs.]

nckler, L. S., and Woerheide, J. D. 1968. WEEKLY HEIGHT ROWTH OF COTTONWOOD. For. Sci. 14 (2): 212-6. [3 refs.]

gl, M. 1964. [AUTONOMOUS WINTER DORMANCY IN ARIOUS BUDS AND ORGANS OF THE POPLAR.] Arch. rstw. 13 (2): 169-76. 35 refs. [G.g.ru.e.]
'ports on the winter dormancy of root initials, cambium, and rious buds in 15-cm. cuttings taken from one-year shoots of pulus X 'canadensis' cv. 'Forndorf'. The dormancy of basal buds is less deep than that of more distal buds on the main or condary shoots. Root primordia and cambium have a dormancy tonomously controlled. Removal of leaves in mid-September did t influence the progress from predormancy to deep rest in buds.

Vogl, M. 1966. [LEAF-FALL AND AUTUMN TRANSLOCATION IN LEAVES OF POPLAR.] Arch. Forstw. 15 (5/6): 641-51. [37 refs. [G.g.ru.e.].]
Short day-length was found to be a primary factor in controlling leaf-fall, influenced secondarily by minimum daily temperature, water content of the soil, and onset of bud dormancy. Light intensity was not significant.

182 SYNECOLOGY, PLANT SOCIOLOGY

182.2

Wilson, R. E. 1970. SUCCESSION IN STANDS OF POPULUS DELTOIDES ALONG THE MISSOURI RIVER IN SOUTH-EASTERN SOUTH DAKOTA. Amer. Midl. Nat. 83 (2): 330-42. [18 refs. B.A.P.]
Raw shore-lines and sand-bars are usually first colonized by Salix interior. After stabilization, P. deltoides usually becomes dominant, with Salix spp. as subordinate species. Regeneration of P. deltoides seems to cease after 15-25 years, and as this species declines other hardwoods such as Fraxinus pennsylvanica and Ulmus americana become more important.

182.3

Johnson, W. C. 1972. THE FOREST OVERSTORY VEGETATION ON THE MISSOURI RIVER FLOODPLAIN IN NORTH DAKOTA. [Abstract]. Dissertation Abstracts International. B 32 (10): 5742-5743 [E., ORS, Order No. 72-12,870]
Reports an intensive study of the ecology and environmental factors in 34 sample stands.

187 VEGETATION TYPES

Crites, R. W., and Ebinger, J. E. 1969. VEGETATION SURVEY OF FLOODPLAIN FORESTS IN EAST-CENTRAL ILLINOIS. Transactions of the Illinois Academy of Science, Springfield 62, (316-30). [7 refs. N.L.L.]
Presents the results of a survey of six areas in the flood-plain forest of the Embarras River valley. Data are given on the species composition and structure of the forests, natural regeneration, and the ground flora.

Phillippe, P. E., and Ebinger, J. E. 1973. VEGETATION SURVEY OF SOME LOWLAND FORESTS ALONG THE WABASH RIVER. Castanca 38 (4): 339-349 [E., 7 ref.]
Counts of seedlings and saplings suggest a slow progression from pioneer species such as Populus deltoides and Salix nigra to the more shade-tolerant species, A. saccharinum.

2 SILVICULTURE

nsbrough, T. [Editor]. 1970. SILVICULTURE AND MANAGE-ENT OF SOUTHERN HARDWOODS. 19TH ANNUAL)RESTRY SYMPOSIUM. Louisiana State University Press, Baton uge. pp. xxii + 145 + 5 plates. [Many ref. Price £3.56].]

23 REGENERATION AND FORMATION OF STANDS

231 NATURAL REGENERATION

hnson, R. L. 1965. REGENERATING COTTONWOOD FROM ATURAL SEEDFALL. J. For. 63 (1): 33-6. 6 refs.

232 ARTIFICIAL REGENERATION

aszkurewicz, A. 1973. ESTABLISHMENT AND EARLY ROWTH OF POPULUS DELTOIDES BARTR. Ph.D. Dissertation, t. State University, Baton Rouge. XV + 312 p.

adri, S. M. A. 1969. ARTIFICIAL REGENERATION OF)PULUS EUPHRATICA OLIVIER. Pakistan J. For. 19 (2): 5-84. [5 refs. 10 sets of figs.]
escribes and illustrates the flowers, fruiting and phenology of P. phratica, and nursery techniques. Direct sowings in riverain rests can be successfully achieved by attaching capsule-bearing oots to brush wood stakes over a moist soil.

Servicio Nacional Forestal. 1971. [PROCEEDINGS OF THE FIRST ARGENTINE FOREST CONGRESS – 6 TO 11 OCTOBER, 1969. [PART OF] SESSION A-J.] Servicio Nacional Forestal, Buenos Aires. pp. 83-128. [Es.Pt.]
Includes papers on cutting material, economics of afforestation and forest nurseries.

232.1

Giordano, E. 1969. [PRELIMINARY OBSERVATIONS ON A COMPARATIVE PLANTING OF POPULUS DELTOIDES BARTR.] Cellulosa e Carta 20 (3): 42-45. [It.]

Randall, W. K. 1973. SUPERIOR COTTONWOODS ARE DEVELOPED AT DELTA STATION. Mississippi, Agricultural and Forestry Experiment Station MAFES Res. Highlights (Miss. Agric. For. Exp. Stn.) 37 (7): 5-6.

232.11

Barrett, R. L., and Woodvine, F. 1971. POSSIBILITIES FOR IRRIGATED FORESTRY IN THE RHODESIAN LOWVELD. For. Res. Pap. Rhod. For. Comm. No. 1, pp. 50. [7 ref.]
Tabulates and discusses data from 138 unreplicated trial plots of trees from 13 genera and 45 species established since 1964 under irrigated conditions.

Eldridge, K. G. 1970. POPULUS DELTOIDES INTRODUCTIONS. Aust. For. Dev. Inst. Newsletter. December.

232.12

Avanzo, E. 1972. NURSERY VARIABILITY OF BASAL AREA AND BRANCH NUMBER IN POPULUS DELTOIDES BARTR. IN CENTRAL AND SOUTHERN ITALY. In Proceedings of the Joint Symposia for Forest Tree Breeding of Genetics Subject Group, IUFRO, and Section 5, Forest Trees, SABRAO. Tokyo, Japan, Government Forest Experiment Station of Japan. B-6(V), 1-5 [E., 5 ref.]
In a study of 731 clones belonging to 60 families raised from seed of 18 American provenances in two Italian nurseries (Spello and Eboli), b.a. at the end of the second year was negatively correlated with latitude of provenance.

Avanzo, E. 1974. [NOTES ON THE VARIABILITY OF SOME PROVENANCES OF POPULUS DELTOIDES INTRODUCED INTO ITALY.] Informatore Botanico Italiano 6 (1): 94-100. [It., 8 ref.]
Discusses characteristics of 76 families belonging to 18 provenances, and 38 families belonging to 8 provenances, introduced from Mississippi and Oklahoma respectively.

Avanzo, E. 1972. [VARIATION IN HEIGHT INCREMENT AND SOME LEAF CHARACTERISTICS OF POPULUS DELTOIDES SEEDLINGS AS RELATED TO LATITUDE OF ORIGIN.] Pubblicazioni del Centro di Sperimentazione Agricola e Forestale 11 (2): 95-117 [It.e., 24 ref.]
A series of P. deltoides seedlings in their second year, raised from 76 seed sources in the USA between 30° 16' and 44° 37' N., were studied at Spello, near Perugia (lat. 42° 58' N., long. 12° 37' E.) in 1968. The correlation with latitude for the whole year's growth was negative. For planting in central and S. Italy, provenances from below the 39th parallel are the most suitable.

Avanzo, E. 1974. [VARIABILITY IN DIMENSIONS OF 64 PROVENANCES OF POPULUS DELTOIDES BARTR. AND FACTORS THAT MIGHT HAVE INFLUENCED THE VARIATIONS.] Cellulosa e Carta 25 (5): 24-29. [It.e.]

Dhir, N. K., and Mohn, C. A. 1974. GROWTH AND FLOWERING OF NC-99 COTTONWOOD SEED SOURCES IN MINNESOTA. Minnesota Forestry Research Notes No. 253, 4 pp. [E., 1 ref.]
A provenance trial with P. deltoides indicated after 7 years that stock for planting in Minnesota should be selected from populations north of 38° N.

Dimitri, L. 1971. PAPPELN UND PAPPELZUCHTUNG IN KANADA. Holzzucht, Reinbek 25 (4): 37-39. [10 Abb., 3 Lit. Ang.]

Eldridge, K. G., Rout, A. R., and Turnbull, J. W. 1972. PROVENANCE VARIATION IN THE GROWTH PATTERN OF POPULUS DELTOIDES. Aust. For. Res. 5 (4): 44-50. [1 ref.]
Seedlings from the southern states of USA retained their foliage later in autumn than northern provenances. By the end of that season the southern provenances were markedly superior in height.

Giordano, E. 1968. PRELIMINARY OBSERVATIONS ON A COMPARATIVE PLANTATION OF POPULUS DELTOIDES NEAR ROME. [Docum.] 13th Sess. Int. Poplar Comm., Montreal 1968 No. FO:CIP/13/19, pp. 7.
Eighteen clones from Illinois and 240 from Mississippi, planted in 1962, grew rapidly at first, but after 6 years only 3 clones exceeded the control (P. 'I-214') in b.a. and 5 in volume.

Giordano, E. 1974. [PRELIMINARY OBSERVATIONS ON THE PROVENANCES OF POPULUS DELTOIDES BARTR. FROM OKLAHOMA IN ITALY.] Cellulosa e Carta 25 (5): 30-37. [It.e.]

Mohn, C. A., and Pauley, S. S. 1969. EARLY PERFORMANCE OF COTTONWOOD SEED SOURCES IN MINNESOTA. Minn. For. Res. Note No. 207, pp. 4.
P. deltoides seedlings from 6 sources in the central portion of the species' range indicated that high growth rate of low-latitude sources was offset by winter injury, seed from sources as low as 38°N. may be of use in Minnesota.

232.13

Bagley, W. T. 1973. HYBRID POPLAR CLONES COMPARED. Journal of Forestry 71 (1): 26-27 [E.]

Hattemer, H. H., Hinkelmann, K., and Maschning, E. 1964. [FIRST RESULTS OF A FIELD TRIAL WITH BLACK POPLAR HYBRIDS.] Repr. from Zuchter 34 (6/7): 257-60. 5 refs. [G.g.]
Ranking of clones and the degree of interaction between clone and site varied considerably. It is estimated that a trial on one site yields only 15% of the possible information on the value of the clone.

Kaszkurewicz, A., and Thielges, B. A. 1972. POPULUS IN THE LOWER MISSISSIPPI VALLEY: RESEARCH FOR THE FUTURE. LSU For. Note La. Sch. For. No. 99, pp. 4. [12 ref.]
Discusses the need for research on Poplar clones best adapted to the less fertile sites in the Mississippi delta.

Koster, R. 1972. [ELEVEN NEW POPLAR CLONES: A GUIDE.] Populier 9 (1): 2-7. [Ni.]

Krall, J. 1971. [POPLARS: DATA ON THEIR PHENOLOGY AND GROWTH IN URUGUAY.] Bol. Dep. For. Uruguay No. 17, (8-18 + 4 gphs.). [Es.e., 6 ref.]
Gives the results of observations on a plantation of P. deltoides cv. 'Carolino' and six clones of P. X 'canadensis' at the School of Agronomy, Cerro Largo, Uruguay.

Mohn, C. A., and Randall, W. K. 1973. INTERACTION OF COTTONWOOD CLONES WITH SITE AND PLANTING YEAR. Canadian Journal of Forest Research 3 (3): 329-332 [E.f., 8 ref.]
Reports a study in which 25 clones of P. deltoides were established on each of two sites in Mississippi in three successive years.

Mohn, C. A., Randall, W. K., and McKnight, J. S. 1970. FOURTEEN COTTONWOOD CLONES SELECTED FOR MIDSOUTH TIMBER PRODUCTION. US For. Serv. Res. Pap. Sth. For. Exp. Sta. No. SO-62, pp. 17. [4 ref.]

Pande, D. C. 1973. INITIAL PERFORMANCE OF POPULUS DELTOIDES IN THE TERAI OF UTTAR PRADESH, INDIA. Indian Forester 99 (1): 12-18 [E.]

Pourtet, J. 1964. [THE IMPROVEMENT OF POPLARS BY SELECTION; SOME PROMISING INTRODUCTIONS.] Rev. for. franc. 16 (10): 725-33. 4 refs. [F.]
Gives the growth of two American clones P. deltoides 'S.P. 1371' and P. trichocarpa 'S.P. 126'.

Randall, W. K. 1973. MISSISSIPPI COTTONWOODS OUTPERFORM LOCAL CLONES NEAR CAIRO, ILLINOIS. US Forest Service Research Note, Southern Forest Experiment Station No. SO-164, 3 pp. [E., 5 ref.]
Reports results of a trial at three locations of 50 clones of P. deltoides.

Randall, W. K., and Cooper, D. T. 1973. PREDICTED GENOTYPIC GAIN FROM COTTONWOOD CLONAL TESTS. Silvae Genetica 22 (5/6): 165-167 [E., 10 ref.]
Reports studies from 50 clones of P. deltoides planted at three sites. The genotype X environment component of variance was as large as the genotypic component for height growth measured after one year, but in later years it was only half that of the genotypic component.

Thielges, B. A., and Leben, C. 1971. TESTING FOR IMPROVED COTTONWOOD STRAINS. Ohio Rep. Res. Develop. Agr. Home Econ. Natur. Resourc. 56 (3): 38-41.

232.2

Baker, J. B., and Blackmon, B. G. 1973. SUMMER FALLOWING HELPS ESTABLISH COTTONWOOD ON OLD FIELDS. Mississippi Agricultural and Forestry Experiment Station MAFES Res. Highlights (Miss. Agric. For. Exp. Stn.) 36 (6): 5.

Baker, J. B., and Blackmon, B. G. 1973. SUMMER FALLOWING IMPROVES SURVIVAL AND GROWTH OF COTTONWOOD ON OLD FIELDS. USDA Forest Service Research Note, Southern Forest Experiment Station No. SO-149, 3 pp. [E.]
Site-preparation treatments included cover cropping (with winter rye/vetch), deep ploughing (16 in deep), summer fallowing (disking

ur times between June and Aug.), and summer fallowing plus rbicide (trifluralin), separately or combined.

oadfoot, W. M., and Bonner, F. T. 1966. SOIL COMPACTION OWS EARLY GROWTH OF PLANTED COTTONWOOD. Tree ant. Notes No. 79, (13-4). [4 refs.]
study showed that when sandy-loam soils are compacted to a bulk nsity of 1·60, the root and shoot growth of planted P. deltoides ttings is considerably retarded.

ielges, B. A., Linnartz, N. E., and Leach, C. P. 1974. BURNING OGGING RESIDUE IMPROVES SITE FOR COTTONWOOD ANTATIONS . . . ASH VALUABLE. Tree Planters' Notes 25 (4): 5 [E., 1 ref.]

ielges, B. A., Linnartz, N. E., and Leach, C. P. 1974. GROWTH ESPONSE OF COTTONWOOD ON BOTTOMLAND SOILS LTERED BY SLASH BURNING. LSU Forestry Notes, Louisiana ate University & A & M College No. 108, 3 pp. [E., 3 ref.]
esents results of an investigation into changes in the chemical operties of a soil caused by burning slash and the resulting effects the growth of P. deltoides.

232.214

oessner, R. A. 1972. WEED CONTROL BY HERBICIDES ROMOTES GROWTH OF COTTONWOOD CUTTINGS. Tree anters' Notes 23 (2): 17-18. [E.]

232.3

vanzo, E. 1970. [INCREASE IN HEIGHT OF POPULUS DELOIDES MARSH IN NURSERY IN FUNCTION OF THE ATITUDE]. Cellulosa e Carta 21 (3): 36-38. [It.]

232.312

vanzo, E. 1968. OBSERVATIONS OF THE SIZE VARIATIONS F THE SEEDS OF POPULUS DELTOIDES. [Docum.] 13th Sess. t. Poplar Comm., Montreal 1968 No. FO:CIP/13/20, pp. 7.

232.314

IcConnell, J. L. 1973. ESTABLISHMENT OF THE UNITED TATES FOREST TREE SEED CENTRE. In Proceedings, 12th outhern Forest Tree Improvement Conference. 153-156 [E.]

232.32

iordano, E. 1969. [OBSERVATIONS ON NURSERY BEHAVIOR F POPULUS DELTOIDES BARTR.] Cellulosa e Carta 20 (3): 1-24. [It.]

ewari, K. M. 1970. [BEHAVIOUR OF AMERICAN POPLAR UTTINGS IN LALKUA RESEARCH NURSERY.] Indian Forest 6 (9): 713-714.

232.322

Martin, J. W., and Carter, M. C. 1967. NITROGEN IMPROVES GROWTH OF POPULUS DELTOIDES NURSERY STOCK. Tree lant. Notes 18 (3): 24-6. [7 refs.]
Reports on a study to determine the influence of N growth of P. eltoides and concentration of major nutrient elements in the oliage.

enningsfeld, F. 1964. [DEFICIENCY SYMPTOMS IN NURSERY PLANTS.] Phosphorsaure, Essen 24 (3/4): 199-212 + 14 photos). 7 refs. [G.g.] H.S.B.
Discusses trials with forest species grown in peat enriched with ombinations of nutrients and trace elements.

Still, S. M., Dirr, M. A., and Gartner, J. B. 1974. EFFECT OF NITROGEN AND COMPOSTING ON DECOMPOSITION OF BARKS FROM FOUR HARDWOOD SPECIES. Forest Products ournal 24 (7): 54-56 [E., 14 ref.]

232.324

Blackmon, B. G., and Gammage, J. L. 1971. SIZE OF COTTONWOOD NURSERY STOCK RELATED TO SEED-BED DENSITY AND ROW SPACING. Tree Plant. Notes 22 (4): 16-7. [1 ref.]
The study reported that production of suitable seedlings will be near maximum with a density of ca. 16 seedlings/ft^2 of bed.

232.328

Anonymous. 1967. [VEGETATIVE PROPAGATION TECHNIQUES.] Proc. Pl. Propag. Soc. 17, (113-38, 289-343). [71 refs. E.M.B.]

Avanzo, E. 1968. OBSERVATIONS ON THE SUCCESS VARIABILITY OF POPULUS DELTOIDES CUTTINGS IN THE NURSERY. [Docum.] 13th Sess. Int. Poplar Comm., Montreal 1968 No. FO:CIP/13/16, pp. 7.
The importance of early selection for rooting ability is stressed.

Brown, J. C., and Carter, M. C. 1971. CUTTING ORIENTATION AND ROOT DEVELOPMENT OF COTTONWOOD. Circ. Ala. Agric. Exp. Sta. No. 186, pp. 9. [7 ref.]
P. deltoides were planted right way up and inverted, and grown with and without various auxin treatments.

Farmer, R. E., Jr. 1966. ROOTING DORMANT CUTTINGS OF MATURE COTTONWOOD. J. For. 64 (3): 196-7. 3 refs.

Frison, G. 1967. [TRIALS ON ROOTING POPULUS DELTOIDES CUTTINGS WITH POOR ROOTING ABILITY.] Proc. 14th Congr. Int. Union For. Res. Organ., Munich 1967 Pt. III, Sect. 22, (278-98). [F.f.e.]

Giordano, E. 1968. OBSERVATIONS ON THE BEHAVIOUR OF POPULUS DELTOIDES IN THE NURSERY. [Docum.] 13th Sess. Int. Poplar Comm., Montreal 1968 No. FO:CIP/13/17, pp. 7.

Lux, A., and Luxova, M. 1967. DEVELOPMENT OF VASCULAR BUNDLES IN POPLAR ROOTS GROWING ON SHOOT CUTTINGS OF VARYING QUALITY. Biologia, Bratislava 22 (3): 166-71. [10 refs. [E.e.slovak.ru.] I.I.E.]

McConnell, J. L. 1971. THE RAPID EXPANSION OF 14 SELECTED COTTONWOOD CLONES. In Proceedings, 11th Conference on Southern Forest Tree Improvement. 244-251 [E., 7 ref.]

Ragonese, A. E., Rial Alberti, F., and Sonvico, V. 1972. [ROOTING OF CUTTINGS OF POPULUS DELTOIDES 'I 63/51'.] Idia Suplemento Forestal 7, 69-76 [Es.e., 4 ref.]
Methods tested were slantwise basal cut, and wedge-shaped cut.

Randall, W. K., and Miller, A. J. E. 1971. MIST PROPAGATION RECOMMENDED FOR EXPANDING COTTONWOOD CLONES RAPIDLY. Tree Plant. Notes 22 (4): 9-13. [14 ref.]
P. deltoides clones can be multiplied by removing 6-in green-wood sections from elongating shoots of parent plants, placing them in a rooting medium, and spraying them lightly with a water mist.

Sato, T. 1974. [CALLUS INDUCTION AND ORGAN DIFFERENTIATION IN ANOTHER CULTURE OF POPLARS.] Journal of the Japanese Forestry Society 56 (2): 55-62 [Jap.e., 17 ref.]
Describes experiments on the propagation of 3 hybrid Aspen trees.

Shipman, R. D. 1974. GIBBERELLIN AFFECTS ROOTING OF HYBRID POPLAR CLONE NE-222. Tree Planters' Notes 25 (1): 19-21. [E., 6 ref.]

232.41

Frison, G. 1972. [STUDIES ON ROOTING OF PLANTING STOCK OF POPULUS DELTOIDES VAR. DELTOIDES.] Cellulosa e Carta 23 (11): 29-58 [It.f.e.de., 17 ref.]

Maisenhelder, L. C., and McKnight, J. S. 1968. COTTONWOOD SEEDLINGS BEST FOR SITES SUBJECT TO FLOODING. Tree Plant. Notes 19 (3): 15-6. [1 ref.]

Phares, R. E., and White, G. 1972. LARGE STOCK, DEEP PLANTING IMPROVE COTTONWOOD GROWTH IN UPPER MISSISSIPPI VALLEY. Tree Planters' Notes 23 (4): 16-17 [E., 4 ref.]

Schlesinger, R. C., and Nashland, C. O. 1971. SEEDLINGS AS GOOD AS TRANSPLANTS FOR COTTONWOOD PLANTING. Tree Plant. Notes 22 (2): 23. [5 ref.]

232.42

Frison, G. 1972. [INFLUENCE OF PLANTING DEPTH ON THE ESTABLISHMENT AND GROWTH OF POPLAR SAPLINGS.] Cellulosa e Carta 23 (3): 31-40 [It.f.e.de., 3 ref.]
Describes comparative trials on the effectiveness of planting two-year-old 'poles' of Populus 'I-214' (which roots easily) and P. deltoides 'Lux' (sometimes difficult to root) with an ordinary soil auger vs. the French Castelbajac drilling machine.

Rakotomanampison, M. 1971. [THE ESTABLISHMENT OF PLANTING TRIALS WITH POPULUS DELTOIDES.] Terre Malgache No. 10, 241-251 [F., OAEc]
The development of suitable plantation techniques, including complete removal of laterals at planting time to encourage the leader, weeding, and application of fertilizers, is discussed.

White, G. 1968. A TECHNIQUE FOR DEEP PLANTING AND CLEAN CULTIVATION OF COTTONWOOD. J. For. 66 (2): 119-22. [4 refs.]

232.43

Krinard, R. M. 1971. 12 X 12 INITIAL SPACING BEST IN COTTONWOOD PLANTATIONS. Tree Plant. Notes (4): 17-9. [1 ref.]
Summarizes 7 years of growth data which indicate that a 12 x 12-ft spacing might be near optimum.

Minckler, L. S. 1970. SPACING, THINNING AND PRUNING PRACTICES FOR YOUNG COTTONWOOD PLANTATIONS. U.S. For. Serv. Res. Note Nth. Cent. For. Exp. Sta. No. NC-95, pp. 4. [2 refs.]
Five spacings were tested on 1-acre plots of P. deltoides in three areas in S. Illinois.

Palashev, I., Manolova, I., and Nikolov, V. 1973. [GROWTH AND YIELD OF POPULUS DELTOIDES AT DIFFERENT SPACINGS ON SITES AWAY FROM THE RIVERS IN THE NE PART OF THE THRACE/TUNDZHA POPLAR REGION.] Gorskostopanska Nauka 10 (1): 35-43 [Bulg.ru.e., 14 ref.]
Gives details of the performance up to age 12 years of plantations established at spacings of 2 X 2, 3 X 3, 4 X 4, 5 X 5, and 6 X 6 in SE Bulgaria.

Tingle, A. C., and Laar, A. van. 1971. THE SILVICULTURE OF POPULUS DELTOIDES. S. Afr. For. J. (76), (14-8). [5 ref.]
Reports results after 3 years of a thinning experiment in Natal, where close spacings are favoured.

232.44

Briscoe, C. B. 1973. EXTENDED PLANTING SEASONS FOR SYCAMORE AND COTTONWOOD. USDA Forest Service Research Note, Southern Forest Experiment Station No. SO-160, 3 pp. [E.]
Seedlings and cuttings of Platanus occidentalis and cuttings of Populus deltoides were planted in different months in four consecutive years in Mississippi with or without irrigation, and evaluated after one growing season.

232.5

Blackmon, B. G. 1971. LARGE PLANTING HOLES NOT NEEDED FOR COTTONWOOD CUTTINGS AND SEEDLINGS IN MISSISSIPPI DELTA. US For. Serv. Res. Note Sth. For. Exp. Sta. NO. SO-132, pp. 2. [4 ref.]
The survival and height growth (up to 3 years) of 20-in or 32-in setts or seedlings of P. deltoides, planted in auger holes 9 in wide and 18 or 30 in deep, were similar to those of bar-planted 20-in setts on prepared sites on silt loam or clay.

Kaszkurewicz, A. 1964. A PRELIMINARY TEST OF DEEP-PLANTING COTTONWOOD CUTTINGS. LSU For. Note La. Sch. For. No. 59, pp. 2. 2 refs.
Cuttings of P. deltoides were planted in the field at depths of 1-6 ft. in a clay soil. Better survival and growth resulted from deep planting. Cuttings planted at 4 ft. produced the greatest height growth.

233 AFFORESTATION

Lorio, P. L., Jr., and Gatherum, G. E. 1965. RELATIONSHIP OF TREE SURVIVAL AND YIELD TO COAL-SPOIL CHARACTERISTICS. Res. Bull. Ia. Agric. Exp. Sta. No. 535, (394-403). 18 refs.

Lorio, P. L., Jr., and Gatherum, G. E. 1966. GROWTH O EASTERN COTTONWOOD IN RELATION TO COAL-SPOI CHARACTERISTICS. Iowa St. J. Sci. 41 (1): 41-53. [12 ref: O.R.E.]
Height growth of 9- to 19-year-old P. deltoides growing on spo mounds in five localities in Iowa was measured and correlated wit various soil properties and with foliar nutrient status.

Sheikh, M. I. 1974. AFFORESTATION IN WATERLOGGED ANI SALINE AREAS. Pakistan Journal of Forestry 24 (2): 186-192 [E 8 ref.]
Results indicate that, with site preparation (deep ploughing, use o Sesbania aegyptiaca as green manure, trenching, flow irrigation an fertilizer treatment), species can be grown in areas affected b waterlogging and areas not too highly saline.

Simon, M. 1964. [THE ESTABLISHMENT OF POPLAR PLANTA TIONS ON SANDS BY DEEP PITTING AND BORING.] Erdesz Kutatas., Budapest 60 (1/3): 387-413. 2 refs. [Hu.hu.ru.g.]
Intensive methods were studied with a view to extending planting t the poorer sands of Hungary, which are otherwise unsuited to th hybrid Black Poplars.

Toth, J. 1965. [THE FOREST ASPECT OF A PLANTATION IN THE SAHARA.] Rev. for. franc. 17 (10): 674-95. 9 refs. [F.]

236 CARE OF REGENERATION OR PLANTATIONS IN THE INITIAL STAGES OF ESTABLISHMENT

Carter, M. C. 1964. PRELIMINARY STUDIES ON CHEMICAL WEED CONTROL IN COTTONWOOD PLANTATIONS. Proc. 17th Ann. Sth. Weed Conf. (262-6). 3 refs. O.W.
Five chemicals were tested as pre-emergence and one as post emergence weedkillers in recently established P. deltoides planta tions on an Alabama bottomland site.

Geyer, W. A. 1974. EFFECTS OF WEED CONTROL AND FERTILIZER IN ESTABLISHING HARDWOOD SEEDLINGS. Tree Planters' Notes 25 (2): 3-4 [E., 3 ref.]

Naidenova-Yaneva, T. 1973. [GROWTH AND YIELD OF POPULUS DELTOIDES IN RELATION TO HOEING IN THE FIRST FEW YEARS.] Gorskostopanska Nauka 10 (6): 33-40 [Bulg.ru.e.]
Plantations in Bulgaria, established at spacings of 2 X 2 to 6 X 6m on alluvial soil, were hoed 0, 1, 2, or 3 times a year during the growing season for the first four years. Data are given on survival and growth of the plantations up to 13 years.

236.1

Carter, M. C., and White, E. H. 1971. THE NECESSITY FOR INTENSIVE CULTURAL TREATMENT IN COTTONWOOD PLANTATIONS. Circ. Ala. Agric. Exp. Sta. No. 189, pp. 11. [16 ref.]
A review of recent research on P. deltoides, with emphasis on nutrition and chemical weed control.

237 AMELIORATION OF FOREST SITES

Blackmon, B. G., and White, E. H. 1972. NITROGEN FERTILIZATION INCREASES COTTONWOOD GROWTH ON OLD-FIELD SOIL. USDA Forest Service Research Note, Southern Forest Experiment Station No. SO-143, 5 pp. [E., 14 ref.]
N(150 lb/acre as NH_4NO_3) and P were applied, in May 1970, to a 6-year-old plantation of P. deltoides on a N-deficient flood-plain site in Mississippi. Volume increment and foliar N and P contents, 4 months later, showed a large response to N. There was no significant response to P alone at 100 lb/acre.

Broadfoot, W. M. 1967. SHALLOW-WATER IMPOUNDMENT INCREASES SOIL MOISTURE AND GROWTH OF HARDWOODS. Proc. Soil Sci. Soc. Amer. 31 (4): 562-4. [5 refs.]

Garbaye, J. 1974. [FIRST RESULTS OF A FERTILIZER EXPERIMENT WITH POPULUS TRICHOCARPA 'FRITZI PAULEY' ON A FOREST SOIL WITHOUT A WATER TABLE IN EASTERN FRANCE.] Revue Forestiere Francaise 26 (5): 379-387 [F., 3 ref.]

Rasson, F. L., Attoe, O. J., and Boyle, J. R. 1970. EFFECT OF GIBBERELLIC ACID IN FERTILIZER PACKETS ON GROWTH OF COTTONWOOD AND SILVER MAPLE. Proc. Soil Sci. Soc. Amer. 34 (5): 826-8. [12 refs.]

237.6

Cone, B. W. 1972. ECONOMIC FEASIBILITY OF AN INTEGRATED COTTONWOOD PLANTATION UTILIZING A NUCLEAR POWER REACTOR. Journal of Forestry 70 (10): 620-623. [E., 4 ref.]

24 TENDING OF STANDS AND TREES

242 THINNINGS

Laar, A. van. 1970. [PRELIMINARY RESULTS OF A POPLAR THINNING TRIAL IN SOUTH AFRICA.] Forstwiss. Cbl. 89 (3): 141-52. [G.e., 14 refs.]
Discusses 3-year results of a trial in which 8-year Populus deltoides plantations in the mist belt of Natal were thinned from below.

245 TENDING OF TREES

Anonymous. 1974. [CUTTING BACK AND PRUNING [POPULUS] 'FRITZI PAULEY'.] Revue Forestiere Francaise 26 (3): 229-230. [F.]
Brief advice on the merits of (1) cutting back branches in the crowns of young trees to ensure good form (not recommended as this clone shows strong apical dominance), and (2) pruning (which should be done annually from the third or fourth year after planting).

Sachsse, H. 1965. [INVESTIGATION ON THE EFFECT OF PRUNING ON THE FORMATION OF COLOURED HEARTWOOD AND TENSION WOOD IN SOME POPLAR VARIETIES.] Holz Roh- u. Werkstoff 23 (11): 425-34. 31 refs. [G.g.e.] P.R.
Pruning caused an increase in the % of dark heartwood and of tension wood. This disadvantage should be taken into account when deciding the intensity and duration of pruning.

Woessner, R. A. 1972. EPICORMIC SPROUTING OF EASTERN COTTONWOOD CLONES AFFECTED BY PRUNING DATE. Tree Planters' Notes 23 (3): 12. [E., 3 ref.]
Results indicated that maximum sprouting occurred after pruning in March (average 8.9 sprouts up to a height of 4 ft) and minimum after May pruning (average 1.9).

26 COMBINATIONS OF FORESTRY WITH AGRICULTURE

262 FUEL AND FODDER FORESTS

Akhtar, M. A., and Walters, C. S. 1974. DIGESTIBILITY OF COTTONWOOD BY RUMINANT MICROORGANISMS. Illinois, Agricultural Experiment Station, Ill. Res. 16 (1): 17-18.

263 IRRIGATED FORESTS

Kawitz, E., Karschon, R., and Mitrani, K. 1966. GROWTH AND CONSUMPTIVE WATER USE OF TWO POPLAR CLONES UNDER DIFFERENT IRRIGATION REGIMES. Repr. from Israel J. agric. Res. 16 (2): 77-88. [8 refs. [E.e.].]
Optimum results were obtained with the one-week irrigation interval in the first year and with the 2-week interval from the second year on.

266 SHELTER BELTS, WINDBREAKS

Al'-Saffar, M. H. 1970. [THE GROWTH OF SHELTERBELTS PLANTED WITH FAST-GROWING SPECIES AT THE L'GOV EXPERIMENTAL BREEDING STATION IN THE KURSK REGION.] Lesn. Z. 13 (2): 151-4. [Ru.]
Presents and discusses growth data for Populus balsamifera, P. deltoides and Betula verrucosa. At age 19 years, on very fertile soils, P. balsamifera and P. deltoides, reached a mean height of 22·2-22·6 m.

Lindbo, M. T., Heintz, R. H., and Lana, E. P. 1972. A SURVEY OF GROWTH AND SURVIVAL OF SHELTERBELTS IN THE DOUGLAS CREEK RECREATION AREA. Research Report, Agricultural Experiment Station, North Dakota State University No. 38, 14 pp. [E., 23 ref.]

Sander, D. H. 1970. SOIL WATER AND TREE GROWTH IN A GREAT PLAINS WINDBREAK. Soil Sci. 110 (2): 128-35. [11 refs.]

4 FOREST INJURIES AND PROTECTION

41 GENERAL TECHNIQUE OF FOREST PROTECTION. TYPES OF INJURY

414.4

Martin, J. W., and Carter, M. C. 1966. TOLERANCE OF COTTONWOOD [POPULUS DELTOIDES] TO CERTAIN HERBICIDES. Bull. Ala. Agric. Exp. Sta. No. 372, pp. 17. [28 refs. Smry. 5 tbls.]

42 INJURIES FROM INORGANIC AGENCIES (EXCLUDING FIRES)

422 TEMPERATURE INFLUENCES. INSOLATION

Chiba, S. 1965. [OBSERVATIONS ON FROST CRACK OCCURRING IN YOUNG STANDS OF POPLARS AND ALDER.] Tech. Note Oji Inst. For. Tree Impr., Kuriyama, Hokkaido No. 42, pp. 4. [Jap.e.]
Severe frost crack in 4-year-old Poplars was caused by temperatures of −20° to −30° C. Cracks occurred mainly on the sides of trees exposed to early afternoon sun, at a height of 30-170 cm. above ground.

Johnson, R. L., and Krinard, R. M. 1965. TIPS FOR MANAGING DROUGHT-STRICKEN COTTONWOODS ALONG THE LOWER MISSISSIPPI RIVER. U.S. For. Serv. Res. Note Sth. For. Exp. Sta. No. SO-24, pp. 4. [2 refs.]
A seven-year study of lower Mississippi river valley P. deltoides affected by the 1952-56 drought showed that mortality depended on proportion of crown dieback and on crown size.

Wagenbreth, D. 1965. [THE OCCURRENCE OF TWO LETHAL STAGES DURING HEATING OF POPLAR LEAVES.] Flora, Jena 156A (1): 116-26. 14 refs. [G.g.e.] O.B.D.

422.1

Sakai, A. 1974. MECHANISM OF FROST RESISTANCE IN HIGHLY RESISTANT SHOOTS. Sov. Plant Physiol. 21 (1): 113-117. Ref.

424 SOIL CONDITIONS; EROSION EFFECTS

Hacskaylo, J., and Vimmerstedt, J. P. 1967. APPEARANCE AND CHEMICAL COMPOSITION OF EASTERN COTTONWOOD GROWN UNDER NUTRIENT DEFICIENT CONDITIONS. Res. Bull. Ohio Agric. Res. Developm. Cent. No. 1004, pp. 19. [17 refs.]

Loucks, W. L., and Keen, R. A. 1973. SUBMERSION TOLERANCE OF SELECTED SEEDLING TREES. Journal of Forestry 71 (8): 496-497 [E., 6 ref.]

425 CHEMICAL INFLUENCES (ATMOSPHERIC)

Karnosky, D. F., and Stairs, G. R. 1974. THE EFFECTS OF SO_2 ON IN VITRO FOREST TREE POLLEN GERMINATION AND TUBE ELONGATION. Journal of Environmental Quality 3 (4): 406-409 [E., 25 ref. ORS]

Kozyukina, Zh. T., and Obraztsova, V. I. 1973. [CHANGES IN THE FREE AND BOUND AMINO ACIDS IN [illegible] LEAVES OF

TREES AND SHRUBS UNDER THE INFLUENCE OF THE COKE AND COAL-TAR CHEMICAL INDUSTRY.] Ukrains'ku Botanichnu Zhurnal 30 (3): 332-339 [Ukr.e., 15 ref. APB]

429 MISCELLANEOUS

Witherspoon, J. P., and Curlin, J. W. 1966. RADIOSENSITIVITY OF CLONES OF EASTERN COTTONWOOD. Abstr. in Bull. Ecol. Soc. Amer. 47 (3): 127-8. [A.P.B.]
Dormant cuttings of P. deltoides were given a Co^{60} γ-radiation dose of 7600 rads. Irradiated cuttings and controls were grown in aerated nutrient solutions maintained under constant environmental conditions. Clones were scored for time of shoot and root emergence, growth rates, and biomass production.

44 DAMAGE BY HARMFUL PLANTS. VIRUS DISEASES

441 FOREST WEEDS

Liddle, J. L., and Lana, E. P. 1970. EFFECTS OF HERBICIDES ON TREE GROWTH, TREE CONDITION AND WEED CONTROL IN SHELTERBELTS. Research Report, North Dakota Agricultural Experiment Station, Fargo No. 30, pp. 13. [21 ref. From abstr. in Weed Abstr. 1971 20 (4), (No. 1619). OW]

Walker, N. 1967. GROWTH AND YIELD OF COTTONWOOD IN CENTRAL OKLAHOMA. Bull. Okla. Agric. Exp. Sta. No. B-656, pp. 20. [9 refs.]
A natural stand of P. deltoides was studied from establishment to age 21.

443 FUNGI AND BACTERIA

Castellani, E. 1972. [PROBLEMS CAUSED BY MARSSONINA BRUNNEA TO POPULUS DELTOIDES AND THEIR SOLUTIONS.] Schweiz Pappel-arbeitsgemeinsch Mitt 22: 2-6. [F.]

Grayl, L. E., Jokela, J. J., and Wycoff, H. B. 1965. BLACKSTEM OF COTTONWOOD. Plant Dis. Reptr. 49 (10): 867-8. [2 refs. I.M.I.]
Investigations into 'blackstem' of P. deltoides indicated that it is an infectious disease and not merely the result of inadequate winter storage of cuttings.

443.3

Castellani, E. 1970/1971. [PROBLEMS IN POPLAR GROWING POSED BY MARSSONINA BRUNNEA, AND SOLUTIONS REACHED.] Annali dell' Accademia di Agricoltura di Torino 113, 45-60 [It., 33 ref. CGB]
In six commonly grown Poplar clones exposed to attack by M. brunnea over several years, wood losses reached 45% and were least (15%) in the 'Carolinian' types.

Chiba, O., and Takai, S. 1966. DISTRIBUTION OF ^{14}C-SUGARS FROM $^{14}CO_2$ IN HEALTHY AND LEAF-RUST-INFECTED POPLAR LEAVES. Annals of the Phytopathological Society of Japan, Tokyo 32 (1): 34-9 + 6 photos. [14 refs. [E.e.jap.] I.M.I.]
In three clones artificially infected with Melampsora larici-populina and exposed to $C^{14}O_2$, radioactivity in the six sugars detected was generally greater in infected leaves than in healthy controls.

Eldridge, K. G., Matheson, A. C., and Stahl, W. 1973. GENETIC VARIATION IN RESISTANCE TO POPLAR LEAF RUST. Australian Forest Research 6 (2): 53-59 [E., 9 ref.]
Assessments of growth of P. deltoides and intensity of infection by Melampsora medusae were made in a provenance trial near Sydney. Significant differences in rust infection were found, and most of the variance was between provenances.

Filer, T. H., Jr. 1964. OUTBREAK OF CANKERS ON PLANTATION GROWN COTTONWOODS IN MISSISSIPPI. Plant Dis. Reptr. 48 (7): 588. I.M.I.

Filer, T. H., Jr. 1967. COTTONWOOD CANKERS CAUSED BY PHOMOPSIS MACROSPORA. Abstr. in Phytopathology 57 (5): 458.

Filer, T. H., Jr. 1967. PATHOGENICITY OF CYTOSPORA, PHOMOPSIS AND HYPOMYCES ON POPULUS DELTOIDES. Phytopathology 57 (9): 978-80. [9 refs.]
In greenhouse and field inoculation tests in Mississippi, C. chrysosperma, P. macrospera and H. [Fusarium] solani all caused cankers, P. macrospora producing most cankers and C. chrysosperma causing the highest mortality.

Filer, T. H., McCracken, F. I., et al. 1971. SEPTORIA CANKER ON NURSERY STOCK OF POPULUS DELTOIDES. Plant Dis. Reptr. 55 (5): 460-3. [3 ref.]

Quraishi, M. A. 1967. POPULUS EUPHRATICA OLIVIER AND ITS FUNGAL ENEMIES. Pakistan J. For. 17 (1): 119-29. [15 refs., 3 photos, 11 drawings, 1 map.]
An account of the silvicultural characters, ecology, and descriptions of the principal pathogens in W. Pakistan.

Schoeneweiss, D. F. 1967. SUSCEPTIBILITY OF WEAKENED COTTONWOOD STEMS TO FUNGI ASSOCIATED WITH BLACKSTEM. Plant Dis. Reptr. 51 (11): 933-5. [5 refs. I.M.I.]
Of three fungi (Cytospora chrysosperma, Cytosporina acharii and Alternaria sp.) isolated from blackstem cankers on P. deltoides, only C. chrysosperma colonized stem tissues of plants weakened by defoliation, after artificial inoculation.

Toole, E. R. 1965. DETERIORATION OF HARDWOOD LOGGING SLASH IN THE SOUTH. Tech. Bull. U.S. Dep. Agric. No. 1328, pp. 27.

Toole, E. R. 1967. MELAMPSORA MEDUSAE CAUSES COTTONWOOD RUST IN LOWER MISSISSIPPI VALLEY. Phytopathology 57 (12): 1361-2. [5 refs.]
Inoculation tests at Stoneville, Miss., on Larix decidua, L. occidentalis and L. laricina, and reinoculation tests on Populus deltoides, confirmed that the pathogen involved was M. medusae.

Toole, E. R. 1968. WETWOOD IN COTTONWOOD. Plant Dis. Reptr. 52 (10): 822-3. [2 refs.]
In 13 stands along the Mississippi River between Vicksburg and Memphis, 86% of the Populus deltoides > 6 in. in diam. contained wetwood, which had a higher moisture content and pH than normal sapwood.

Wagenbreth, D. 1968. [THE EFFECT OF HEAT SHOCK ON THE SUSCEPTIBILITY OF POPLAR LEAVES TO RUST.] Phytopath. Z. 61 (1): 87-97. [36 refs. [G.g.e.] O.R.S.]
Treatment of attached leaves of Populus deltoides X P. simonii for 90 sec. at 42·5-45° C. increased their susceptibility to attack by Melampsora larici-populina, whereas treatment at 47·5-50° gave increased or sometimes absolute resistance to the rust, lasting ca. 10 days, and inhibited transpiration for 3 days.

Walker, J., and Hartigan, D. 1972. POPLAR RUST IN AUSTRALIA. Australian Plant Pathology Society Newsletter 1 (1): 3. [E., From Review of Plant Pathology 51, 4398.]

Ward, J. C., Kuntz, J. E., and McCoy, E. M. 1969. BACTERIA ASSOCIATED WITH 'SHAKE' IN BROADLEAF TREES. Abstr. in Phytopathology 59 (8): 1056.

Zalasky, H. 1965. ADDITIONAL HOSTS OF DIPLODIA TUMEFACIENS (SHEAR) ZALASKY (MACROPHOMA TUMEFACIENS SHEAR). Repr. from Plant Dis. Reptr. 49 (1): 50. 3 refs.

Zalasky, H., Fenn, O. K., and Lindquist, C. H. 1968. REACTION OF POPLARS TO INFECTION BY SEPTORIA MUSIVA AND DIPLODIA TUMEFACIENS AND TO INJURY BY FROST IN MANITOBA AND SASKATCHEWAN. Plant Dis. Reptr. 52 (11): 829-33. [17 refs.]
Disease incidence varied from very low to very high in 28 Populus clones which were artificially inoculated with D. [Macrophoma] tumefaciens.

444 VIRUS DISEASES

Boccardo, G., Luisoni, E., and Lovisolo, O. 1973. CHARACTERISATION OF AN ITALIAN ISOLATE OF POPLAR MOSAIC VIRUS. In Abstracts of Papers, 2nd International Congress of Plant Pathology, Minneapolis. 0928 [E.]
The main symptoms were bright mosaic, necrosis of midribs, and growth reduction. The virus (morphologically in the Carlavirus group) was sap-transmitted to several herbaceous plants. Purification of the virus is described.

eontovyc, R., and Gemersky, V. 1965. [ATTACK ON VARIOUS ULTIVARS BY POPLAR MOSAIC VIRUS IN SLOVAKIA IN 962.] Lesn. Cas., Praha 11 (7): 649-54. [12 refs. [Slovak.-ovak.ru.e.g.f.].]
he most resistant cultivars were Populus X canadensis cvs. 'I-214', Marilandica' and 'Wislizenii' and P. deltoides var. monilifera.

avratil, S., and Boyer, M. G. 1968. THE IDENTIFICATION OF OPLAR MOSAIC VIRUS IN CANADA. Canad. J. Bot. 46 (5): 22-3. [16 refs. O.R.S.]
he virus was isolated from Populus deltoides subsp. angulata grown rom cuttings derived from a tree imported in 1902 from Berlin. he mosaic appeared to be identical with the European form.

avratil, S., and Boyer, M. G. 1972. ULTRASTRUCTURAL HANGES IN LEAF TISSUE OF POPULUS DELTOIDES SUBSP. NGULATA AIT. INFECTED WITH POPLAR MOSAIC VIRUS. anadian Journal of Forest Research 2 (3): 308-312. [E.f., 23 ref.]

45 DAMAGE BY ANIMALS

451 MAMMALS

rinard, R. M. 1973. COTTONWOOD RECOVERS FROM DEER ROWSING. Tree Planters' Notes 24 (2): 37-38. [E.]
rees of P. deltoides in a plantation in Mississippi, that had been eavily browsed in their first year, grew rapidly in the second eason, during which weeds were controlled and deer excluded. lost terminals were beyond the reach of deer at the end of the eason. Only where mortality has been extremely heavy is ploughing nder and replanting advantageous.

453 INSECTS

brahamson, L. P., and Newsome, L. 1972. TREE AGE NFLUENCES TRUNK BORER INFESTATIONS IN COTTON-VOOD PLANTATIONS. Forest Science 18 (3): 231-232. [E., 1 ef.]

brahamson, L. P., Newsome, L., and Bouler, T. P. 1973. PPLICATOR FOR GRANULAR SYSTEMIC INSECTICIDES IN OTTONWOOD NURSERIES AND PLANTATIONS. USDA Forest ervice Research Note. Southern Forest Experiment Station No. O-165, 2 pp. [E.]

ibasov, K. A. 1971. [APHID PESTS OF THE DESERT POPLAR POPULUS EUPHRATICA] IN [S. AND] SE KAZAKHSTAN APHIDINEA).] Trudy Instituta Zoologii, Akademiya Nauk Kazakhskoi SSR 50, 18-20. [Ru., 6 ref.] From Review of Applied ntomology, A 62, 2613.
In account of the biology of three aphids that do considerable amage in epidemic years.

Baker, B. H. 1970. OCCURRENCE OF MALACOSOMA NCURVUM DISCOLORATUM IN ZION CANYON, UTAH LEPIDOPTERA: LASIOCAMPIDAE). Pan-Pacific Entomologist 6 (1): 27-33. [E., 5 ref.]

Brown, L. R., and Eads, C. O. 1969. UNNAMED AND LITTLE-KNOWN INSECTS ATTACKING COTTONWOOD IN SOUTHERN CALIFORNIA. J. Econ. Ent. 62 (3): 667-74. [5 refs.]

Coster, J. E. 1973. SYSTEMIC INSECTICIDES EFFECTIVE AGAINST POPLAR TENTMAKER IN COTTONWOOD PLANTATIONS. Tree Planters' Notes 24 (1): 33-34. [E., 3 ref.]

Coster, J. E., Merrifield, R. G., and Woessner, R. A. 1972. EVALUATION OF FOUR SYSTEMIC INSECTICIDES AGAINST THE COTTONWOOD TWIG BORER. Journal of Economic Entomology 65 (2): 612-613. [E., 4 ref.]

Dennis, C. J. 1974. MORE ABOUT THE BUFFALO TREEHOPPER ON A MISSISSIPPI RIVER ISLAND (HOMOPTERA: MEMBRACIDAE). Entomol. News 85 (1): 29-30.

Gagne, R. J. 1966. A NEW SPECIES OF PRODIPLOSIS DIPTERA: CECIDOMYIIDAE) FOUND IN LEAF CURLS ON POPULUS DELTOIDES. Ann. Ent. Soc. Amer. 59 (6): 1154-7. [4 efs. O.R.S.]

Head, R. B., and Neel, W. W. 1973. THE COTTONWOOD LEAF BEETLE: OBSERVATIONS ON THE BIOLOGY AND REPRODUCTIVE POTENTIAL IN MISSISSIPPI. Journal of Economic Entomology 66 (6): 1327-1328. [E., 2 ref.]
Reports of a study of the fecundity (on Populus deltoides) of overwintered females of Chrysomela scripta: results suggest a greater reproductive potential in the S. than that reported in the N. of the USA.

Hepburn, G. A. 1964. REVIEW OF FOREST AND TIMBER INSECTS IN SOUTH AFRICA. Technical Communication, Department of Agricultural Technical Services, Pretoria No. 12, (52-7). [E.] I.I.E.

Hepburn, G. A., Prinsloo, H., and Loedolff, J. 1966. LOBOBUNEA EPITHYRENA M. & W. (ORDER LEPIDOPTERA, FAMILY SATURNIIDAE), A POTENTIAL PEST OF EXOTIC PLANTATIONS. Bosb. Suid-Afr. (6), (65-78 + 2 plates). [2 refs. [E.e.afr.].]
This moth occurs from Zanzibar to Durban and in N. and E. Transvaal.

Kristek, J. 1968. [THE INSECT FAUNA OF POPLARS: SPECIES FOUND IN THE PITH OF DEAD STEMS.] Acta Univ. Agric., Brno (Fac. Silv.) 37 (1): 37-41 + 4 plates. [Cz.e.g., 9 refs.]
Gives brief illustrated notes on 16 species of Hymenoptera found in 103 of a total of 229 dead stems collected from a 2-year plantation of Populus deltoides var. monilifera.

Malek, R. B. 1969. POPULATION FLUCTUATIONS AND OBSERVATIONS OF THE LIFE CYCLE OF XIPHINEMA AMERICANUM ASSOCIATED WITH COTTONWOOD (POPULUS DELTOIDES) IN SOUTH DAKOTA. Helminthol Soc. Wash. Proc. 36 (2): 270-274.

Morris, R. C. 1967. BIOLOGY OF GYPSONOMA HAIMBACHIANA (LEPIDOPTERA: OLETHREUTIDAE), A TWIG BORER IN EASTERN COTTONWOOD [POPULUS DELTOIDES]. Ann. Ent. Soc. Amer. 60 (2): 423-7. [8 refs. O.R.S.]
G. haimbachiana causes serious stunting, forking and other malformations in P. deltoides, especially young trees, from Ontario to Mississippi.

Neel, W. W. 1969. COMPARISON OF SYSTEMIC INSECTICIDES BY DIP TREATMENTS FOR CONTROL OF THE COTTONWOOD LEAF BEETLE. J. Econ. Ent. 62 (1): 265-7. [1 ref.]
Survival of Chrysomela scripta larvae on P. deltoides cuttings treated with various insecticides showed that the most effective were disulfoton, phorate and carbofuran.

Payne, T. L., and Stewart, J. E. 1971. EVIDENCE FOR A SEX PHEROMONE IN THE COTTONWOOD TWIG BORER. J. Econ. Ent. 64 (4): 987-8. [5 ref.]
Describes field experiments with Gypsonoma haimbachiana (a pest of Populus deltoides) on the response of ♂s and♀s to traps baited with either live or dead virgin ♀s, or live virgin ♂s.

Payne, T. L., Woessner, R. A., and Mastro, V. C. 1972. EVALUATION OF COTTONWOOD CLONAL SELECTIONS FOR RESISTANCE TO COTTONWOOD TWIG BORER ATTACK. Journal of Economic Entomology 65 (4): 1178-1179. [E., 7 ref.]
Presents data on the incidence of attack by Gypsonoma haimbachiana on 36 clones of P. deltoides and clone NE 316.

Stewart, J. W., and Payne, T. L. 1972. PARASITES AND PREDATORS OF THE COTTONWOOD TWIG BORER [GYPSONOMA HAEMBACHIANA] IN TEXAS [ON POPULUS DELTOIDES]. Environmental Entomology 1 (5): 669-670. [E., 3 ref.] From Review of Applied Entomology, A 61, 1264.

Vivani, W. 1965. [SELECTION OF FOREST PLANTING STOCK FOR RESISTANCE TO INSECT DAMAGE IN SOUTHERN EUROPE.] Monti e Boschi 16 (4): 45-51. 11 refs. [It.]
A general review of the problem of finding resistant strains of species already in use and introducing new species resistant to insect damage.

Woessner, R. A., and Payne, T. L. 1971. AN ASSESSMENT OF COTTONWOOD TWIG-BORER ATTACKS. Proceedings, 11th Conference on Southern Forest Tree Improvement (98-107). [E., 5 ref.]

459 OTHER ANIMALS

Massey, C. L., and Hinds, T. E. 1970. NEMATODES FROM ASPEN CANKERS IN COLORADO AND NEW MEXICO. Repr. from

Canad. J. Zool. 48 (1): 97-108. [9 refs.]
Nematodes were discovered in the necrotic tissues of Cenangium and Ceratocystis cankers of P. deltoides during studies on th etiology of these canker diseases in Colorado.

5 FOREST MENSURATION

52 MEASUREMENTS OF STEM DIMENSIONS AND VOLUME OF TREES, STANDS, FORESTS AND TIMBER

Grigorasenko, I. A., and Babaev, A. 1968. [MENSURATIONAL ASPECTS OF RIPARIAN WOODLANDS [IN SOVIET CENTRAL ASIA].] Probl. Osvoenija Pustyn No. 4, (58-64). [[Ru.e.] From abstr. in Referat. Z., Moskva 1969 (5.56.128). [Ru.] N.L.L.]
Describes a study of P. diversifolia stands in the Murgab valley. Variation in tree age and in stem taper was considerable.

524 DETERMINATION OF THE VOLUME OF TREES AND STANDS

Grosscurth, W. 1974. SIND PAPPELSORTEN-PRUFUNGEN NOTWENDIG? GEGENDARSTELLUNG ZU: "KRITIK UND ENTFALSCHUNG EINER DISSERTATION" VON R. MULLER. 2. TEIL. Forstpflanzen-Forstsamen, Strassenhaus 14 (4): 101-104. [1 Tab., 6 Lit. Ang.]

524.2

Carter, M. C., and White, E. H. 1971. DRY WEIGHT AND NUTRIENT ACCUMULATION IN YOUNG STANDS OF COTTONWOOD (POPULUS DELTOIDES BARTR.). Circ. Ala. Agric. Exp. Sta. No. 190, pp. 14. [19 ref.]
Dry-matter production did not, however, appear to be closely related to site quality over the range of sites studied. Nutrient concentrations varied with crown class and position in the crown, and generally exceeded the values reported for conifers.

524.3

Gusejnov, A. M., Gusejnova, L. A., and Sadyhov, N. A. 1968. [TAPER AND VOLUME TABLES FOR 'CANADIAN POPLAR' IN AZERBAIJAN.] Lesn. Z., Arhangel'sk 11 (5): 36-9. [1 ref. [Ru.].]

Mohn, C. A., and Krinard, R. M. 1971. VOLUME TABLES FOR SMALL COTTONWOODS IN PLANTATIONS. U.S. For. Serv. Res. Note Sth. For. Exp. Sta. No. SO-113, pp. 4.

Tingle, A. C. 1966. SILVICULTURE, VOLUME AND YIELD OF POPULUS DELTOIDES. Annale Universiteit van Stellenbosch 41 A (10): 473-516 + 3 dgms., 3 tbls.). [29 refs.]

Woessner, R. A. 1973. STEM VOLUME ESTIMATION IN YOUNG COTTONWOOD CLONES – WHICH EQUATION? In Proceedings, 12th Southern Forest Tree Improvement Conference. 270-275. [E., 5 ref.]
Stem form characteristics were studied in 9 clones and a 'nursery-run lot' of P. deltoides, 32 to 42 ft. tall. Differences in o.b. form quotient were closely related to differences in bark thickness between clones.

53 SPECIAL MEASUREMENTS OF TREES AND STANDS (CROWN DIMENSIONS, STAND DENSITY, ETC.)

Madgwick, H. A. I. 1965. COMMENT ON THE PAPER "SOM SIZE AND SHAPE RELATIONSHIPS BETWEEN TREE STEM AND CROWNS". Iowa St. J. Sci. 40 (1): 99-100. 1 ref.

54 ASSESSMENT OF SITE QUALITY

Broadfoot, W. M. 1969. PROBLEMS IN RELATING SOIL TO SIT INDEX FOR SOUTHERN HARDWOODS. For. Sci. 15 (4): 354-6 [20 refs.]
Soil characters were determined for 739 0·2-acre plots from s States in the southern U.S.A., and these were correlated with a and height growth. Relations between site index and soil characte were determined graphically and by multiple regression. None of th derived equations predicted site index with sufficient accuracy f investment planning.

Broadfoot, W. M. 1970. TREE-CHARACTER RELATIONS I SOUTHERN HARDWOOD STANDS. U.S. For. Serv. Res. Note St For. Exp. Sta. No. SO-98, pp. 7. [2 refs.]
Site index, b.a., d.b.h., number of 16-ft. logs, butt-log grade, tre vigour, and incidence of insect attack on stems are compared.

56 INCREMENT; DEVELOPMENT AND STRUCTURE OF STANDS

Bonilla, J. A., et al. 1964. [FOURTH CONTRIBUTION O FOREST MENSURATION: ESTIMATION OF INCREMENT AN YIELD OF SOME FOREST SPECIES, RECORDED IN TH DEPARTMENT OF PAYSANDU.] Bol. Dep. For. Uruguay No. 1 (16-22). [Span.]

Bonilla, J. A. 1965. [EIGHTH CONTRIBUTION ON FORES MENSURATION: GROWTH OF PINES, EUCALYPTS AN SALICACEAE IN URUGUAY.] Bol. Dep. For. Uruguay No. 1 (1-9). 17 refs. [Span.span.e.]

Stamenkovic, V., and Miscevic, V. 1971. [COMPARATIV INVESTIGATIONS ON DIAMETER INCREMENT OF VARIOU FOREST TREE SPECIES.] Sumarstvo 24 (7/8): 3-14. [Sh.e., ref.]
Compares results of measurements of diameter increment with a Arnberg dendrometer and a band dendrometer.

58 SURVEYING AND MAPPING. AERIAL SURVEY

Olson, C. E., Jr. 1970. SEASONAL CHANGE IN FOLIA REFLECTANCE OF FIVE BROADLEAVED FOREST TRE SPECIES. Abstr. of thesis, in Dissert. Abstr. int. 31 B (5): 2397- [Order No. 70-21,744. Price: M. $4.00; x.$6.00. pp. 125. ORS]
Discusses the results of a study in Illinois in 1962 on reflectanc from foliage in five broadleaved and two coniferous plantations relation to season and moisture stress.

6 FOREST MANAGEMENT

64 FORESTRY AS A BUSINESS: GENERAL

Ellertsen, B. W., and Rogers, L. 1965. GUIDE TO PLANNING FARM FORESTRY ACTIVITIES ON COASTAL PLAIN ASSOCIATED SOILS IN WEST TENNESSEE AND ADJOINING AREAS. Division of Forestry Development, Tennessee Valley Authority, Norris, Tenn. pp. 44. [10 refs.]

65 SPECIAL BUSINESS PROBLEMS OF TIMBER-GROWING

Sinden, J. A. 1970. POPLAR GROWING AND FARM ADJUST MENT ON THE NORTH COAST OF NEW SOUTH WALES Review of Marketing and Agricultural Economics, Sydney 38 (3) 121-38. [From abstr. in World agric. Econ. rural Sociol. Abstr. 197 13 (1), (No. 1237).]

Walker, N. 1969. ECONOMIC AND MANAGEMENT MODELS FOR COTTONWOOD IN CENTRAL OKLAHOMA. Bull. Okla. Agric. Exp. Sta. No. B-664, pp. 18. [8 refs.]
Production in thinned and unthinned P. deltoides stands in central Oklahoma was studied over a 22-year period.

651 CALCULATION OF COSTS AND PROFITABILITY

Laar, A. van, and Tingle, A. C. 1965. ECONOMIC ASPECTS OF POPLAR GROWING FOR MATCHWOOD PRODUCTION. S. Afr. For. J. No. 53, (14-24). 2 refs.

651.7

Tingle, A. C., and Laar, A. van. 1972. THE ECONOMICS OF THINNINGS IN POPLAR PLANTATIONS. Mededeling, Fakulteit van Bosbou, University of Stellenbosch No. 31, 18 pp. [E.]

7 MARKETING OF FOREST PRODUCTS. ECONOMICS OF FOREST TRANSPORT AND THE WOOD INDUSTRIES

Barger, R. L., and Ffolliott, P. L. 1971. PROSPECTS FOR COTTONWOOD UTILIZATION IN ARIZONA. Progr. Agr. Ariz. 23 (3): 14-16.

8 FOREST PRODUCTS AND THEIR UTILIZATION

81 WOOD AND BARK: STRUCTURE AND PROPERTIES

811 STRUCTURE. IDENTIFICATION

Larson, P. R., and Isebrands, J. G. 1974. ANATOMY OF THE PRIMARY-SECONDARY TRANSITION ZONE IN STEMS OF POPULUS DELTOIDES. Wood Sci. Technol. 8 (1): 11-26. Ref.

811.1/2

Necesany, V. 1969. THE EFFECT OF LIGHT DEFICIENCY ON THE FORMATION OF SECONDARY XYLEM. Wood Sci. Technol., N.Y. 3 (2): 100-8. [19 refs. [E.e.g.].]

811.1

Balatinecz, J. J., and Farrar, J. L. 1966. PATTERN OF RENEWED CAMBIAL ACTIVITY IN RELATION TO EXOGENOUS AUXIN IN DETACHED WOODY SHOOTS. Repr. from Canad. J. Bot. 44 (8): 1108-10 + 1 plate. [6 refs.]

Farrar, J. L. 1970. DOWNWARD MOVEMENT OF AUXIN AND CAMBIAL ACTIVITY IN LONG STEM CUTTINGS OF SEVERAL HARDWOODS. Extr. from Rep. Res. For. Bot. Glendon Hall. Fac. For. Univ. Toronto 1969/70, (9).
Experiments were made on disbudded 50-cm dormant cuttings, treated with IBA at the upper end; some controls had the top two buds left.

Isebrands, J. G. 1970. CELLULAR VARIATION WITHIN THE WOOD OF EASTERN COTTONWOOD. Abstr. of thesis, in Dissert. Abstr. int. 30B (11): 4875. [Order No. 70-7707. pp. 208. ORS]
The within-tree variation of vessel, ray and fibre % per unit area, cross-sectional fibre dimensions, sp. gr., fibre length, and number of vessels per unit area was measured at different points vertically and radially in two trees.

Isebrands, J. G. 1972. PROPORTION OF WOOD ELEMENTS WITHIN EASTERN COTTONWOOD. Wood Science 5 (2): 139-146. [E., 17 ref.]
A study of samples removed from discs cut at 1-foot intervals from the stem of two 21-year-old dominant Populus deltoides trees indicated the existence of systematic variation in the proportions of the various wood elements.

Isebrands, J. G., and Larson, P. R. 1973. SOME OBSERVATIONS ON THE CAMBIAL ZONE IN COTTONWOOD. IAWA Bulletin No. 3, 3-11. [E., 14 ref.]
Describes, with 8 photomicrographs, studies of the cambial zone of Populus deltoides made with a light microscope, using preparation techniques recently developed for the electron microscope, and bright-field, phase-contrast, polarized-light and interference microscopy.

Scurfield, G., Michell, A. J., and Silva, S. R. 1973. CRYSTALS IN WOODY STEMS. Botanical Journal of the Linnean Society 66 (4): 277-289 + 7 pl. [E., 38 ref. OBD]
Scanning electron microscopy was used to study the location and form of crystals in the stems of 40 species of woody perennials.

Whitmore, F. W. 1968. AUXIN AND CELL WALL FORMATION IN THE CAMBIAL DERIVATIVES OF PINE AND COTTONWOOD. For. Sci. 14 (2): 197-205. [25 refs.]
IAA stimulated the incorporation of sugar into walls of cambial derivatives of P. deltoides trees.

Wilcox, J. R., and Farmer, R. E., Jr. 1968. VARIATION IN FIBER LENGTH OF EASTERN COTTONWOOD IN THE LOWER MISSISSIPPI VALLEY. Tappi 51 (12): 574-6. [10 refs.]
Most of the variation was associated with individual trees within stands.

811.158

Isebrands, J. G., and Bensend, D. W. 1972. INCIDENCE AND STRUCTURE OF GELATINOUS FIBERS WITHIN RAPID-GROWING EASTERN COTTONWOOD. Wood and Fiber 4 (2): 61-71. [E., 23 ref.]

811.2

Kaeiser, M., and Boyce, S. G. 1965. THE RELATIONSHIP OF GELATINOUS FIBERS TO WOOD STRUCTURE IN EASTERN COTTONWOOD (POPULUS DELTOIDES). Repr. from Amer. J. Bot. 52 (7): 711-5. [11 refs.]
An increase in the numbers of gelatinous fibres in samples of P. deltoides was found to be associated with decreased diameter and increased wall thickness of non-gelatinous fibres.

811.7

Andrews, L. G. 1968. HISTOCHEMICAL AND AUTORADIOGRAPHICAL STUDIES OF SIEVE ELEMENT DIFFERENTIATION IN POPULUS DELTOIDES MARSH. Abstr. of thesis in Dissert. Abstr. 28 B (10): 4014. [O.R.S.]
Discusses the results of a study of changes in the localization and relative amounts of DNA and RNA during sieve-element differentiation.

812 PHYSICAL AND MECHANICAL PROPERTIES

Cop, D., and Reginac, L. 1971. [THE PERMEABILITY OF WOOD TO LIQUIDS AND GASES.] Holztechnol. 12 (1): 29-33. [De.e.ru., 15 ref. PR]
Apparatus for measuring the permeability of wood to liquids and to gases is described. A linear relation was found between axial permeability to air and water. Permeability values exhibit a high degree of variability.

Fogg, P. J., and Choong, E. T. 1971. GAS PERMEABILITY OF GAMMA-IRRADIATED WOOD. LSU Wood Util. Note La. Sch. For. No. 21, pp. 3. [1 ref.]
A study of the effect of Y-irradiation on the permeability of various wood samples.

812.237

Isaacs, C. P., Choong, E. T., and Fogg, P. J. 1971. PERMEABILITY VARIATION WITHIN A COTTONWOOD TREE. Wood Sci. 3 (4): 231-7. [8 ref.]

812.3

Farmer, R. E., Jr., and Wilcox, J. R. 1966. SPECIFIC GRAVITY VARIATION IN A LOWER MISSISSIPPI VALLEY COTTONWOOD POPULATION. Tappi 49 (5): 210-1. [11 refs.]
Statistical analysis of phenotypic differences in Populus deltoides showed that most of the variation in sp.gr. (0·32-0·46) was between trees; it was concluded that, for tree improvement programmes, individual high-density trees should be sought throughout the population.

Guiher, J. K. 1968. RELATION OF SPECIFIC GRAVITY TO RINGS-PER-INCH IN COTTONWOOD CONSTRUCTION LUMBER. For. Prod. J. 18 (3): 22. [2 refs.]
Sp.gr. was assessed by the immersion method and rings per inch by the average measurement at the end-grain surface. Number of rings per inch is apparently not a strong indicator of sp.gr.

Herpka, I. 1973. [VARIATION IN THE SPECIFIC GRAVITY OF JUVENILE WOOD IN ORTETS OF POPULUS DELTOIDES VAR. DELTOIDES FAMILIES.] Topola 17 (98/99): 34-42. [Sh.e., 16 ref.]
Gives results of a study of the sp. gr. of juvenile wood 2-year-old trees grown in Yugoslavia, and representing 466 ortets from 40 half-sib families. In general, sp.gr. decreased with increasing b.a. and with decreasing latitude or provenance.

Kaeiser, M., and Boyce, S. G. 1964. AVERAGES AND CORRELATION COEFFICIENTS BETWEEN SPECIFIC GRAVITY AND A NUMBER OF WOOD PROPERTIES OF EASTERN COTTONWOOD, INCLUDING GELATINOUS FIBRES. Abstr. in Amer. J. Bot. 51 (6, Part 2): 673. O.B.D.

Walters, C. S., and Bruckmann, G. 1965. VARIATION IN SPECIFIC GRAVITY OF COTTONWOOD AS AFFECTED BY TREE SEX AND STAND LOCATION. J. For. 63 (3): 182-5. 9 refs.
Mean difference of N. and S. borings was significantly larger for ♀ than for ♂s; sex of trees within a stand contributed little to variation in sp. gr.

812.7

Walters, C. S., Guiher, J. K., and Norton, H. W. 1971. THE STATISTICAL RELIABILITY OF PREDICTING BENDING STRENGTH FROM STRENGTH RATIO TABLES. For. Prod. J. 21 (6): 47-56. [3 ref.]

813 WOOD CHEMISTRY

Kosikova, B., and Polcin, J. 1972 [STUDY OF THE CONDITIONS OF ACIDOLYSIS OF WOOD IN ALIPHATIC ALCOHOLS.] Holzforschung 26 (4): 125-131. [De.e., 7 ref. PR]
Effects of the type and concentration of catalyst, temperature, and duration of reaction, on the yields of lignin and sugars in the acidolysis of wood of Picea abies, Populus monilifera [P. deltoides] and Fagus sylvatica were examined.

Moore, W. E., and Effland, M. J. 1974. CHEMICAL COMPOSITION OF FAST-GROWTH JUVENILE WOOD AND SLOW-GROWTH MATURE SYCAMORE AND COTTONWOOD. Tappi 57 (8): 96-98 [E., 15 ref.]

Sarkanen, K. V., Chang, H. M., and Allan, G. G. 1967. SPECIES VARIATION IN LIGNINS. III. HARDWOOD LIGININS. Tappi 50 (12): 587-90. [5 refs.]

813.2

Hart, J. H., and Hillis, W. E. 1974. INHIBITION OF WOOD-ROTTING FUNGI BY STILBENES AND OTHER POLYPHENOLS IN EUCALYPTUS SIDEROXYLON. Phytopathology 64 (7): 939-948. [E., 39 ref.]

815 EFFECT OF GROWTH FACTORS ON STRUCTURE AND PROPERTIES

Bhagwat, S. G. 1968. A STUDY OF THE EFFECTS OF NITROGEN, PHOSPHORUS, POTASSIUM AND MULCHING ON THE WOOD ANATOMY OF POPULUS DELTOIDES MARSH. Abstr. of thesis, in Dissert. Abstr. 28B (9): 3596. [O.R.S.]
In a study covering the first two years after treatment, N. P and K and mulching all significantly increased leaf length and width, tree height, diameter growth, wood sp.gr., etc.

Boyce, S. G., and Kaeiser, M. 1964. IMPROVE WOOD QUALITY IN EASTERN COTTONWOOD BY BREEDING AND SELECTING FOR STRAIGHT, VERTICAL STEMS. Sth. Lumberm. 209 (2609): 115-8. 22 refs. P.R.

Necesany, V., and Cetlova, J. 1969. [EFFECT OF EXTERNAL GROWTH CONDITIONS ON THE STRUCTURE OF POPLAR WOOD.] Holzforschung 23 (3): 73-82. [G.e., 42 refs. P.R.]
The layers visible within the growth rings of the fast-growing P. monilifera were examined microscopically, and changes in the proportion of vessels and fibres, reaction-wood fibres and fibre length were related to meteorological data.

82 CONVERSION, SHAPING, ASSEMBLY AND FINISHING OF WOOD: GENERAL

Cooper, G. A., and Barham, S. H. 1971. THE PERFORMANCE OF A HOUSE PAINT ON TWO OVERLAYS ON COTTONWOOD SIDING. For. Prod. J. 21 (3): 53-6.
Six-year exposure tests showed that overlays improved the quality of Eastern Cottonwood cores.

Thompson, M. C., and Choong, E. T. 1968. EFFECT OF SURFACE SMOOTHNESS AND WOOD-TYPE ON THE GLUING CHARACTERISTICS OF EASTERN COTTONWOOD AND BLACK WILLOW. LSU Wood Util. Note La. Sch. For. No. 9, pp. 4 [3 refs.]
In gluing tests on P. deltoides and Salix nigra, with polyvinyl, urea and casein glues, it was found that there was no difference in bond strength of the two species or of heartwood and sapwood.

Toit, A. J. du. 1964. THE INFLUENCE OF TYLOSES ON THE MANUFACTURE OF MATCHES. S. Afr. For. J. No. 50, (27-38).
The abnormal production in P. deltoides of tyloses in the sapwood is shown to be the cause of 'wet head' in matches.

83 TIMBER MANUFACTURING INDUSTRIES AND PRODUCTS

Anonymous. 1964. VENEER CUTTING AND DRYING PROPERTIES OF COTTONWOOD. U.S. For. Serv. Res. Note U.S. For. Prod. Lab., Madison No. FPL-044 (rev.) pp. 4. 4 refs.

Booth, H. E. 1969. REPORT ON PRODUCTION OF PLYWOOD FROM HYBRID POPLAR AT RIVERINA PLYWOOD COMPANY, WAGGA, N.S.W. Aust. Timb. J. 35 (6): 43, 45.
Tests showed that a good product could be made, with or without Pinus radiata core plies.

Jo, J., Kang, S., and Kim, K. 1972. [STUDIES ON THE MANUFACTURING OF THE LAMINATED WOOD WITH POPLAR AND LARCH.] Research Reports of the Forest Research Institute, Korea No. 19, 91-106. [Kor.e., 15 ref.]
Tabulates and discusses data from tests on the wood properties of, and manufacture of laminated timber from Poplar and Larch grown on short rotations in Korea.

84 PRESERVATION AND OTHER TREATMENTS TO IMPROVE THE PROPERTIES OF WOOD. DAMAGING INFLUENCES

)uncan, D. A., and Wolfram, H. W. 1970. FENCEPOSTS BUTT-OAKED IN PENTACHLOROPHENOL STILL SOUND AFTER 22 'EARS. U.S. For. Serv. Res. Note Pacif. Sthwest. For. Range Exp. 'ta. No. PSW-221, pp. 3. [2 refs.]

844 ATTACK BY PLANT ORGANISMS

'ois, P. J., and Eslyn, W. E. 1966. DETERIORATION RATES OF /ILLOW AND COTTONWOOD DURING [OUTDOOR] TORAGE IN GEORGIA. For. Prod. J. 16 (11): 17-22. [8 refs.]

achelarescu, F., Vintila, E., and Boiciuc, M. 1964. [THE DURA-ILITY OF WOOD OF RUMANIAN POPLARS OF RAPID ;ROWTH.] Industr. Lemn. 15 (3): 85-7. 6 refs. [Ro.ru.g.f.e.]
'resents the results of laboratory tests on wood using Coniophora erebella and Polystictus versicolor as test fungi.

achs, I. B., Ward, J. C., and Kinney, R. E. 1974. SCANNING :LECTRON MICROSCOPY [SEM] OF BACTERIAL WETWOOD AND NORMAL HEARTWOOD IN POPLAR TREES. In Proc. Workshop SEM & Plant Sci., IIT Res. Inst., Chicago. 453-460 [E., 3 ref.] From Abstract Bulletin of the Institute of Paper Chemistry 5, 1727. LTP.
Study of specimens of P. deltoides, P. grandidentata and P. alba by 'EM, followed by isolation and culture of micro-organisms present, howed that wetwood derives mainly from bacterial infections.

845 ATTACK BY ANIMALS

Kovoor, J. 1964. [CHEMICAL CHANGES IN POPLAR SAWDUST CAUSED BY MICROCEROTERMES EDENTATUS.] C. R. Acad. Sci., Paris 258 (10): 2887-9. 3 refs. [F.f.] O.R.S.
Chemical analyses of sawdust of Populus virginiana inhabited and partly consumed by M. edentatus showed a reduction in the % of cellulose and pentosans and an insignificant reduction in the lignin %, combined with a change in its content of methoxyl groups.

847 DRYING (SEASONING)

Koberle, M., and Durisova, V. 1969. [DRYING POPLAR SAWN TIMBER.] Drevo 24 (10): 294-7. [Slovak.g.e., 10 refs. P.R.]
Results of trials with P. 'Marilandica' and P. [deltoides var.?] monilifera to establish combined air- and kiln-drying schedules suitable for Poplar wood.

847.7

Chen, P. Y. S. 1973. INVESTIGATION OF PRESSURE-SOLVENT-DISPLACEMENT OF MOISTURE IN WOOD. Wood Science 6 (1): 61-64. [E., 8 ref.]

848 TIMBERYARD PRACTICE. HANDLING AND STORAGE OF TIMBER

Feist, W. C., Springer, E. L., and Hajny, G. J. 1971. ENCASING WOOD CHIP PILES IN PLASTIC MEMBRANES TO CONTROL CHIP DETERIORATION. Tappi 54 (7): 1140-2. [13 ref.]
Reports a successful attempt at anaerobic storage of P. deltoides chips using polythene film 20 mil thick to exclude O_2.

Springer, E. L., Zoch, L. L., Jr., Feist, W. C., and Hajny, G. J. 1973 A TREATMENT THAT SHOWS PROMISE FOR PRESERVING STORED WOOD CHIPS. USDA Forest Service Research Paper, Forest Products Laboratory, Madison No. FPL 216, 5 pp. [E., 6 ref.]

86 PULP INDUSTRIES

862 COMPOSITE MATERIALS MADE WHOLLY OR PARTLY OF WOODY MATTER

Bhagwat, S. 1971. PHYSICAL AND MECHANICAL VARIATIONS IN COTTONWOOD AND HICKORY FLAKEBOARDS MADE FROM FLAKES OF THREE SIZES. For. Prod. J. 21 (9): 101-3. [15 ref.]

89 OTHER FOREST PRODUCTS

892.4

Pearl, I. A., and Darling, S. F. 1971. STUDIES OF THE HOT WATER EXTRACTIVES OF THE BARK AND LEAVES OF POPULUS DELTOIDES BARTR. Canad. J. Chem. 49 (1): 49-55. [24 ref. (Studies on the barks of the family Salicaceae XXVI; Studies on the leaves of the family Salicaceae XII). ORS]

9 FORESTS AND FORESTRY FROM THE NATIONAL AND INTERNATIONAL POINTS OF VIEW

90 GENERAL

Laar, A. van. 1967. IMPROVEMENT OF POPLAR AND POPLAR CULTURE. Bosb. Suid-Afr. (8), (43-52). [5 refs. [E.e.afr.].]
Poplar growing in S. Africa is based on single clone of P. deltoides, and recommends the introduction of new clones, hybrids and provenances for local trials.

904 GENERAL REGIONAL ACCOUNTS OF FORESTS AND FORESTRY

Bailly, C., Benoit de Coignac, G., and Malvos, C. 1973. [EXPERIMENTS ON POPLARS IN THE MANGORO BASIN (MADAGASCAR).] Bois et Forets des Tropiques No. 151, 3-26. [F.e.es., 31 ref.]
Describes promising Poplar-growing trials in Madagascar in connexion with a 1500-ha planting programme designed to supply a veneer-peeling and match-making industry.

McKnight, J. S. 1970. PLANTING COTTONWOOD CUTTINGS FOR TIMBER PRODUCTION IN THE SOUTH [OF THE U.S.A.]. U.S. For. Serv. Res. Pap. Sth. For. Exp. Sta. No. SO-60, pp. 17. [11 refs.]

McKnight, J. S., and Biesterfeldt, R. C. 1968. COMMERCIAL COTTONWOOD PLANTING IN THE SOUTHERN UNITED STATES. J. For. 66 (9): 670-5. [8 refs.]

Merritt, C., and Bramble, W. C. 1966. POPLAR PLANTATION RESEARCH IN INDIANA – A FIVE-YEAR REPORT. Res. Bull. Ind. Agric. Exp. Sta. No. 818, pp. 15, [9 refs.]
Gives details of performance of a plantation of P. deltoides and P. X eugenei established in 1961.

Walgemoed, D. 1966. [GROWING POPULUS 'GELRICA' IN THE [GELDERLAND] ACHTERHOEK.] Populier, Wageningen 3 (1): 3-5. [Du.]
Discusses the production and planting of setts, tending, fertilizer application, pruning, and rotation, and gives some figures for costs and prices.

91 LAND USE, LAND-USE POLICY, AFFORESTATION POLICY

Ogilvie, W. L. 1970. ECONOMIC ASPECTS OF INTEGRATING POPLAR GROWING WITH BEEF PRODUCTION ON THE NORTH COAST OF NEW SOUTH WALES. Aust. For. Res. 5 (1): 37-46. [1 ref.]

97 INTERNATIONAL FOREST POLICY AND OTHER INTERNATIONAL COLLABORATION

971 CONGRESSES, CONFERENCES

Anonymous. 1968. [INTERNATIONAL POPLAR COMMISSION STUDY TOUR OF THE LOWER MISSISSIPPI VALLEY.] Bull. Serv. Cult. Etud. Peuplier et Saule, Paris (37-85). [20 refs., [F.] 14 figs., 2 tbls.]
Covers subspecies and clones of Populus deltoides under test, stands and plantations and their treatment, utilization and research.

P. GRANDIDENTATA TO P. JAPONO-GIGAS

0 GENERAL

Sonnaville, P. de. 1967. [EXPERIENCES WITH POPULUS 'I-214'.] Populier 4 (4): 64. [Du.]

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

11 SITE FACTORS: CLIMATE, SITUATION, SOIL, HYDROLOGY

114 SOIL. SOIL SCIENCE

Giulimondi, G. 1968. [EFFECTS OF POPLAR LITTER ON THE SOIL. I. POT TRIALS ON LEAF-LITTER DECOMPOSITION.] Pubbl. Cent. Sper. Agric. For., Roma 10 (1): 55-71. [24 refs. [It.it.e.e.] 2 figs., 6 tbls.]

Hannah, P. R., and Zahner, R. 1970. NONPEDOGENETIC TEXTURE BANDS IN OUTWASH SANDS OF MICHIGAN: THEIR ORIGIN, AND INFLUENCE ON TREE GROWTH. Proc. Soil Sci. Soc. Amer. 34 (1): 134-6. [5 refs.]

116 HYDROLOGY. WATER CONSERVATION, SOIL CONSERVATION AND EROSION

Clements, J. R. 1970. STEMFLOW IN A YOUNG STAND OF ASPEN SUCKERS. Bi-m. Res. Notes 27 (4): 31-2. [3 ref.]
The results indicated that stemflow in terms of rain equivalent was nearly 5% of gross rain, a higher % than that reported for mature P. grandidentata in a forest near by.

Clements, J. R. 1971. EVALUATING SUMMER RAINFALL THROUGH A MULTILAYERED LARGETOOTH ASPEN COMMUNITY. Canad. J. For. Res. 1 (1): 20-31. [E. f, 24 ref.]

Clements, J. R. 1972. STEMFLOW IN A MULTI-STORIED ASPEN COMMUNITY. Canadian Journal of Forest Research. 2 (2): 160-165. [E.f., 18 ref.]
Presents mathematical equations describing the relations between the amount of stemflow per canopy layer per storm for four different canopy layers in a multi-storeyed P. grandidentata community.

16 GENERAL BOTANY

160 PLANT CHEMISTRY

Fortescue, J. A. C. 1972. THE USE OF BRANCHES AS A BASIS FOR THE ESTIMATION OF THE COPPER, ZINC, LEAD AND NICKEL STATUS OF A FOREST STAND. Canadian Journal of Forest Research 3 (1): 27-33. [E. £ 7 ref.]

Pearl, I. A., and Darling, S. F. 1964. FURTHER STUDIES ON THE ISOLATION OF GLUCOSIDES FROM THE BARKS AND LEAVES OF POPULUS TREMULOIDES AND POPULUS GRANDIDENTATA. Tappi 47 (6): 377-80. 15 refs.

Pearl, I. A., and Darling, S. F. 1965. FURTHER STUDIES ON THE OCCURRENCE OF GLUCOSIDES IN THE LEAVES OF POPULUS GRANDIDENTATA. Tappi 48 (10): 607-8. 5 refs.
Chloroform, ether, and ethyl-acetate extraction of the hot-water extractives of the leaves showed that salicin and tremuloidin exist per se in the leaves and can be extracted without hydrolysis.

Pearl, I. A., and Darling, S. F. 1965. STUDIES ON THE LEAVES OF THE FAMILY SALICACEAE. II. QUERCETIN-3-GLUCOSIDURONIC ACID FROM POPULUS GRANDIDENTATA LEAVES. J. organ. Chem. 30 (5): 1442. 4 refs. O.R.S.

Ronkov, B., and Evangelatova, N. 1967. [CHANGES IN THE MONO-, DI-, AND TRI-SACCHARIDES IN THE LEAVES AND STEM OF ONE-YEAR SHOOTS OF POPULUS 'I-214'.] Nauc. Trud. Lesoteh. Inst., Sofija (Ser. Gorsko Stop.) No. 15, (227-36). [9 refs. [Bulg.ru.g.].]
Describes a paper-chromatographic study. Fructose, glucose, sucrose and raffinose were identified, and another unidentified ketose was found. Contents were determined in the stem and leaves at intervals during the day and throughout the growing season.

Ronkov, B., and Evangelatova, N. 1967. [INVESTIGATIONS ON THE FREE AMINO ACIDS IN THE LEAVES AND STEM OF ONE-YEAR SHOOTS OF POPULUS 'I-214'.] Nauc. Trud. Lesoteh. Inst., Sofija (Ser. Gorsko Stop.) No. 15, (237-42). [6 refs. [Bulg.ru.g.].]
Describes a paper-chromatographic study. In all, 14 free amino acids were identified, and one other was found but not identified.

Szendrey, I., and Juhasz, M. 1969. [SEASONAL VARIATION IN THE LEAF-CATALASE ACTIVITY OF ROBINIA PSEUDO-ACACIA, TILIA SPP. AND POPULUS 'I-214'.] Erdesz. Faipari Egyetem tud. Kozl. (1), (103-12). [Hu.ru.e.g., 1 ref.]
The greatest activity was found in Robinia leaves in July.

Tatsumi, S. 1965. [CALCIUM METABOLISM IN TREES III. DIURNAL VARIATIONS OF FRACTIONALIZED CALCIUM IN POPLAR CUTTINGS.] J. Jap. For. Soc. 47 (2): 51-7. 14 refs. [Jap.jap.e.e.]
Results of a study of diurnal variation in Ca contents in Populus '[I-]214' indicated that Ca moves alternately between leaves (max. at midnight) and bark (max. at midday).

Tatsumi, S. 1965. [THE CALCIUM METABOLISM IN TREES. IV: THE VARIATION OF THE FRACTIONALIZED CALCIUM CAUSED BY THE LIGHTING TREATMENT IN POPLAR CUTTINGS. (1) LIGHT EXPOSURE TREATMENT AND LIGHT INTERCEPTION TREATMENT.] J. Jap. For. Soc. 47 (9): 326-33. 6 refs. [Jap.jap.e.e.]
Evidence is given that diurnal variation in Ca content is affected by light. Total Ca in leaves decreased, and in petioles and bark increased, on exposure to light, but remained unchanged in woody parts.

Tatsumi, S. 1965. [THE CALCIUM METABOLISM IN TREES. V. EFFECT OF TEMPERATURE VARIATION ON THE FRACTIONALIZED CALCIUM IN POPLAR CUTTINGS: I (THE VARIATION OF THE FRACTIONALIZED CALCIUM OF 30° C. TO 0° C.).] J. Jap. For. Soc. 47 (10): 346-55. 8 refs. [Jap.jap.e.]
The diurnal variations of Ca content found in Poplar cuttings were not caused directly by temperature changes.

Tatsumi, S. 1966. [THE CALCIUM METABOLISM IN TREES. VI. PAPER CHROMATOGRAPH OF WATER SOLUBLE CALCIUM IN POPLAR LEAVES.] J. Jap. For. Soc. 48 (6): 237-44 + 5 photos). [7 refs. [Jap.jap.e.e.].]
Analysis showed the presence of six unidentified Ca compounds in the aqueous extractives of the leaves of Populus 'I-214': the main component is probably Ca gluconate.

Touzet, G., and Heinrich, J. C. 1971. [FOLIAR NUTRIENT CONTENTS OF N, P, K AND Ca IN POPULUS 'I-214'.] Rapp. Ass. For.-Cell. 1970, (103-34). [F.e.de., 11 ref.]

ıe mean foliar nutrient contents differed statistically in relation to ?e age, but were not affected by application of fertilizer. mporary changes in foliar nutrient content did, however, result ɔm the fertilizer applications in response to meteorological factors specially temperature).

ɔuzet, G., and Heinrich, J. C. 1973. [FOLIAR ANALYSIS OF)PULUS 'I-214' AND ITS INTERPRETATION.] In Rapport ınuel, Association Foret-Cellulose 1972. 423-477. [F.e.de., 4 ref.]
ıta are given on variations throughout the growing season in the N, P, K, Ca and Mg contents of the leaves of P. 'I-214' grown in fferent parts of France.

ɔuzet, G., Heinrich, J. C., and Nohn, I. 1970. [FOLIAR NALYSIS AND GROWTH RATE.] C.R. Ass. For.-Cell. 1969, 7-57). [F.e.g., 15 refs.]
asonal changes in contents of N, P, K and Ca and in girth are aphed for each species. Girth increment was related to amounts of liar N and K in Poplar and of P in the conifers.

161 PHYSIOLOGY

ımitrov, K., and Dimitrova, M. 1974. [EFFECT OF FERTI-ZING AND IRRIGATION ON THE RATE OF PHOTO-YNTHESIS IN POPLAR.] Gorskostopanska Nauka 11 (5): 34-41. Bulg.ru.f., 3 ref.]
PK and watering both increased the rate of photosynthesis, the sponse being greater in the pots than in the field.

onnelly, J. R. 1970. SEASONAL CHANGES IN THE PATTERN F PHOTOSYNTHATE TRANSPORT WITHIN ELONGATING HOOTS OF POPULUS GRANDIDENTATA. Abstr. of thesis, in issert. Abstr. int. 31B (5): 2396. [Order No. 70-21,645. pp. 72. RS]

ırukawa, A. 1973. CARBON DIOXIDE COMPENSATION)INTS IN POPLAR PLANT. Journal of the Japanese Forestry)ciety 55 (3): 95-99. [E.jap., 18 ref.]
linear relation was observed between c.p. and O_2 concentration ıd c.p. values increased in leaves subjected to water stress.

ırukawa, A. 1973. PHOTOSYNTHESIS AND RESPIRATION IN)PLAR PLANT IN RELATION TO LEAF DEVELOPMENT.)urnal of the Japanese Forestry Society 55 (4): 119-123. [E.jap., 3 ref.]

agnaire, J. 1967. [ABSORPTION OF Ca^{45} AND ITS ACCUMU-ATION IN TWO YOUNG TREES (POPLAR AND THUJA) URING A FULL GROWTH CYCLE.] In Isotopes in plant utrition and physiology. International Atomic Energy Agency, ienna. pp. 377-90. [23 refs. [F.f.e.] N.L.L.]
he high accumulation of Ca^{45} found in petioles and leaves of opulus 'I-214' make this material suitable for contamination tests espite high individual and seasonal variations.

agnaire, J. 1967. [THE GROWTH RHYTHMS OF POPULUS -214'.] C. R. Acad. Sci., Paris 265D (19): 1387-90. [2 refs. [F.f.]).R.S.]
study of the movement of radio-active Ca in young trees and of he mineral composition of various parts of the tree showed that the rowth cycle falls into 5 distinct phases.

ozlowski, T. T., and Clausen, J. J. 1966. SHOOT GROWTH HARACTERISTICS OF HETEROPHYLLOUS WOODY PLANTS. anad. J. Bot. 44 (6): 827-43 + 4 photos. [31 refs. O.R.S.]

akamura, Y. 1973. [ON THE STERILE CULTURE OF STEM EGMENT OF TREES (I). EFFECTS OF SUGARS ON BUD NCREMENT AND CALLUS FORMATION ON STEM EGMENT.] Journal of the Japanese Forestry Society 55 (5): 61-165. [Jap.e., 7 ref.]
Describes a laboratory experiment to determine the effects of upplying sucrose, glucose and fructose to stem segments of Populus -455', grown aseptically in glass tubes under controlled conditions. No differences in increment were found between buds treated with ucrose, glucose, or fructose at optimum concentration.

antosne Derimova, T. [Pantos, D. T.] 1974. [RESEARCH ON HE GROWTH, NUTRIENT UPTAKE, ASSIMILATION AND RANSPIRATION OF ONE-YEAR-OLD ROOTED CUTTINGS OF OPULUS 'ROBUSTA' AND P. 'I-214'.] Erdeszeti es Faipari gyetem Kiadvanyai No. 19, 97 pp. [Hu.ru.e.de., 28 ref.]
In P. 'I-214', the total uptake of N, P and K, the net assimilation rate, and the respiration rate were all higher than in P. 'Robusta'. However, P. 'I-214' transpired significantly more water than P. 'Robusta' per unit increment in girth. Regressions of girth increment and transpiration on nutrient uptake were determined. Nutrient uptake had no significant influence on net assimilation rate within a clone.

Popa, A. 1970. [THE AMPLITUDE OF SOME PHYSIOLOGICAL PROCESSES IN HYBRID BLACK POPLARS IN RELATION TO SOIL MOISTURE.] Rev. Padurilor 85 (9): 467-72. [Ru., 5 refs.]
Reports the net assimilation rate, transpiration, respiration, increment, and phosphate uptake, during August, of plants grown in Rumania from cuttings in pots of red-brown forest soil.

Tobiessen, P., and Kana, T. M. 1974. DROUGHT-STRESS AVOIDANCE IN THREE PIONEER TREE SPECIES. Ecology 55 (3): 667-670. [E., 23 ref.]

161.34

Donnelly, J. R. 1974. SEASONAL CHANGES IN PHOTO-SYNTHATE TRANSPORT WITHIN ELONGATING SHOOTS OF POPULUS GRANDIDENTATA. Canadian Journal of Botany 52 (12): 2547-2559. [E., 23 ref.]

165 PHYLOGENY, EVOLUTION. HEREDITY, GENETICS AND BREEDING, VARIATION

165.3/.7

Chiarabba, E., Bignami, V., and D'Altan, A. 1970. [RESULTS OF OBSERVATIONS ON THE TECHNOLOGICAL CHARACTER-ISTICS OF SOME NEWLY SELECTED POPLAR CLONES RESISTANT TO DISEASES.] Cellulosa e Carta 21 (8): 31-49. [It.f.e.g.]

Gatherum, G. E., Gordon, J. C., and Broerman, B. F. S. 1967. EFFECTS OF CLONE AND LIGHT INTENSITY ON PHOTO-SYNTHESIS, RESPIRATION AND GROWTH OF ASPEN-POPLAR HYBRIDS. Silvae Genet. 16 (4): 128-32. [19 refs. [E.e.].]

Harrison, C. M., and Valentine, F. A. 1972. PHENETIC AFFINITIES IN SMALL POPULATIONS OF NEW YORK ASPENS. In Proceedings, 19th Northeastern Forest Tree Improvement Conference 1971, 60-76. [E., 13 ref.]
Results of a study to determine the reliability of large numbers of phenotypic characters in distinguishing between Populus tremuloides and P. grandidentata, and to compare putative interspecific hybrids on the basis of traits considered to be reliable.

Nemky, E. 1970. [A COMPARATIVE STUDY OF POPLAR CLONES.] Erdeszeti es Faipari Egyetem Tudomanyos Kozlemenyei No. 1/2, 115-125. [Hu.ru.e.de., 2 ref.]

Takayama, Y. 1968. [STUDIES ON THE BREEDING OF ASPENS. (I). HEIGHT GROWTH IN THE EARLY STAGE OF F_1 SEEDLINGS OF POPULUS SIEBOLDII MIQ. X P. GRANDIDENTATA MICHX.] J. Jap. For. Soc. 50 (9): 267-73. [20 refs. [Jap.jap.e.e.].]
The results are reported of experiments on breeding Aspen hybrids or cultivars suited to sunny slopes or dry sites in Japan.

17 SYSTEMATIC BOTANY

176.1 DICOTYLEDONEAE

Browicz, K. 1966. POPULUS ILICIFOLIA (ENGLER) ROULEAU AND ITS TAXONOMIC POSITION. Acta Soc. Bot. Polon. 35 (2): 325-35. [23 refs. [E.pol.] O.B.D.]
Discusses the taxonomy of P. ilicifolia in relation to the evolution of the whole genus.

Muller, R. 1969. [THE 'GRANDIS' POPLAR.] Bull. Serv. Cult. Etud. Peuplier et Saule (11-21). Transl. by J. Chardenon from part II h of 'Oldstock varieties' of Black Poplar hybrids. [See F.A. 20 No. 4213.]

Ozolin, G. P. 1965. [SOME ASPECTS OF THE SYSTEMATY OF THE BLACK POPLARS GROWING IN [SOVIET] CENTRAL ASIA.] Uzbekskij Biologiceskij Zurnal, Taskent (1), (42-4).

[Ru.uzbek] N.L.L.
Brief notes on several taxa, pointing out that Populus thevestina (not P. pyramidalis) is the most characteristic and typical of the fastigiate Black Poplars in Central Asia and that P. 'Wettstein' and P. X euramericana 'Sacran 79' are identical with P. X euramericana 'I-214'.

18 PLANT ECOLOGY

181 MODE OF LIFE, AUTECOLOGY. SILVICULTURAL CHARACTERS OF TREES

181.2

Pollard, D. F. W. 1970. THE EFFECT OF RAPIDLY CHANGING LIGHT ON THE RATE OF PHOTOSYNTHESIS IN LARGE-TOOTH ASPEN (POPULUS GRANDIDENTATA). Canad. J. Bot. 48 (4): 824-9. [E.f., 8 refs. O.R.S.]

Yoshida, S., and Sakai, A. 1973. PHOSPHOLIPID CHANGES ASSOCIATED WITH COLD HARDINESS OF CORTICAL CELLS FROM POPLAR STEMS. Plant and Cell Physiology 14 (2): 353-359. [E., 15 ref. OBD]
A study on stem bark taken from potted cuttings of Populus canadensis cv. 'I-476', cooled stepwise to -70° C and, after freezing, submerged in liquid N.

181.3

Marinov, M., Naumov, Z., and Fakirov, V. 1974. [POPLAR SITES IN THE BASINS OF THE MAIN RIVERS IN S. BULGARIA.] Gorskostopanska Nauka 11 (4): 3-23. [Bulg.ru.f., 9 ref.]
Distinguishes five groups of sites: transitional Willow/Poplar sites, typical Poplar sites, drained Poplar sites, nominal [marginal] Poplar sites, and sites unsuitable for Poplars.

Palotas, F. 1968. [THE EFFECT OF DEEP PLANTING AND OF SOIL NUTRIENT STATUS ON THE GROWTH OF POPLARS.] Erdesz. Kutatas., Budapest 64 (1/3): 83-92. [Hu.ru.g.]

181.31

Chardenon, J. 1971. [MEASURING SOIL WATER CONTENT.] Bull. Serv. Cult. Etud. Peuplier et Saule (7-12). [F.]

Dekanic, I. 1969. [DEPTH OF WATER TABLE AND SOIL AS IMPORTANT EDAPHIC FACTORS FOR THE GROWTH OF SOME HYBRID BLACK POPLARS ON THE ALLUVIUM OF THE SAVA AND KUPA RIVERS NEAR SISAK.] Sum. List 93 (11/12): 363-86. [Serb.f., 9 refs.]
Gives details of height, diameter and volume growth of four Poplars up to 8 years on a site in Jugoslavia where the mean water table was at a depth of 301 cm.

Frison, G. 1972. [TRANSPLANTING SHOCK AND VARIATIONS IN THE WATER CONTENT OF POPLAR TRANSPLANTS.] Cellulosa e Carta 23 (9): 21-43. [It.f.e.de., 4 ref.]
Reports the results of research on variations in the water content of both bark and wood in various parts of the stems of 2-year-old Populus.

181.32/34

Curro, P., Sertmehmetoglu, Z., and Acar, O. 1965. [INVESTIGATIONS ON THE EFFECT OF SITE [ON] POPULUS X EURAMERICANA CV. 'I-214'.] Tek. Yay. Kavak. Arast. Enst., Izmit No. 3, pp. 39. [Turk.F.]
Compares the growth of P. 'I-214' at five localities and on three soil types in northern Turkey. Wood density was greater in trees growing on clays than on sands, but no differences were found between localities with similar soil types.

Denev, D. A. 1974. [EFFECT OF THE MAIN NUTRIENT ELEMENTS (NPK) ON THE GROWTH OF POPLARS.] Gorskostopanska Nauka 11 (3): 12-26. [Bulg.ru.de., 16 ref.]
Describes pot trials with cuttings of Populus 'I-214' and P. 'Vernirubens' grown in river sand or in alluvial soil with or without the addition of NPK, NP, PK and NK. Responses to fertilizers were more pronounced in the river sand than in the alluvial soil.

Dzekova, M. 1965. [THE RATIO BETWEEN MATERIALS RETAINED IN THE WOOD AND THOSE RETURNED TO THE SOIL IN THE LEAVES, DURING THE FIRST THREE YEARS AFTER ESTABLISHMENT OF SOME HYBRID BLAC POPLARS.] God. Zborn. Zemj-Sum. Fak. Univ. Skopje (Sum.) N 18, (155-204). [39 refs. [Maced.g.].]
Almost 2/3 of the total quantity of mineral nutrients taken up b the roots were returned to the soil by the leaves.

Dzekova, M. 1972. [THE DRAIN ON SOIL MINERALS IN TH PRODUCTION OF POPLAR PLANTS.] Godisen Zbornik n Zemjodelsko-Sumarskiot Fakultet na Univerzitetot Skopj Sumarstvo 24, 37-46 [Ma.de., 5 ref.]
Tabulates data on the amounts (in kg/ha) of organic matter an main chemical constituents (ash, cellulose, N, P, K, Ca) in the leave stems and roots of 1-year-old rooted cuttings of Populus 'I-214', 'I-455', P. 'I-45/51', and P. 'Robusta'.

Frison, G. 1969. [MINERAL LOSSES IN POPLAR PLANT TIONS.] Cellulosa e Carta 20 (6): 5-12. [5 refs. [It.it.f.e.g.].]
The total dry weight, in kg. per tree and per ha., of the leaves, stem and roots in a plantation of Populus 'I-214' (spacing 6 X 6 m.) wa determined after 13 growing seasons, together with their relati content of major nutrients. Data are also given on the nutrien content of wood and bark in the stems in relation to the distanc from ground level.

Giulimondi, G. 1966. [INVESTIGATIONS ON THE MINERA NUTRITION OF POPLAR BY MEANS OF FOLIAR ANALYSIS VARIATIONS OF MINERAL CONTENTS IN FERTILIZE TRIALS.] Pubbl. Cent. Sper. Agric. For., Roma 8, (39-54). [1 refs. [It.it.e.e.].]
In two fertilizer trials in a plantation of Populus 'I-214' on coast sand near Rome, uptake of NP and NPK was studied by folia analysis for two years.

Giulimondi, G. 1970. [MINERAL CONTENTS OF YOUN POPLARS IN THE NURSERY.] Pubbl. Cent. Sper. Agric. Fo 11 (1): 63-74. [It.e.]
The N, P, K and Ca contents of the roots, stems and branches o 2-year-old nursery stock of Populus 'I-214' raised on recent alluvi soil were determined. It is concluded that soil impoverishment b Poplars in the nursery is unlikely to be appreciable.

Giulimondi, G., and Duranti, G. 1974. [THE PATTERN O DRY-MATTER INCREMENT AND USE OF NUTRIENTS B POPLARS DURING THEIR SECOND YEAR IN THE NURSERY. Cellulosa e Carta 25 (11): 3-20 [It.f.e.de., 2 ref.]

Liani, A. 1966. [RESEARCH ON THE INFLUENCE OF TH PHYSICAL PROPERTIES OF THE SOIL ON THE ROOTIN CAPACITY, GROWTH, AND MINERAL NUTRITION O POPLAR.] Pubbl. Cent. Sper. Agric. For., Roma 8, (103-20). [2 refs. [It.it.e.e.].]

Liani, A. 1968. [PRELIMINARY STUDIES ON THE Ca NUTR TION OF POPLAR BY MEANS OF Ca^{45}]. Pubbl. Cent. Sper Agric. For., Roma 10 (2): 81-8. [20 refs. [It.it.e.e.].]
The Ca content of leaves, which was obviously higher with liming showed a decrease with K fertilization. Ca^{45} content in the leave was, on average, higher in the leaves of plants not submitted t liming treatments; this was also the case for the ratio of Ca fron fertilizer to total Ca taken up from soil.

Pantos, D. T. 1966. [NUTRIENT UPTAKE BY POPULUS ROBUSTA AND 'POPULUS ITALICA' [HERE USED FOR P 'I-214'].] Erdesz. Faipari Egyetem tud. Kozl., Sopron (1/2) (89-105). [9 refs. [Hu.ru.g.e.ru.g.e.].]
P uptake was much steadier throughout the growing season than N and K uptake, both of which displayed similar fluctuations.

181.35

Shuja, N., Gilani, U., and Khan, A. G. 1971. MYCORRHIZAL ASSOCIATIONS IN SOME ANGIOSPERM TREES AROUND NEW UNIVERSITY CAMPUS, I. AHORE. Pakistan J. For. 21 (4): 367-73. [11 ref.]

181.36

Funaiola, A. 1967. [THE ROOT SYSTEM OF POPULUS 'I-214' IN SOILS HAVING DIFFERENT WATER TABLES.] Proc. 14th Congr. Int. Union For. Res. Organ., Munich 1967 Pt. III, Sect. 22, (621-35). [F.f.]

bles show numbers of main roots, the area of their horizontal jection, weight, total volume, and depth of penetration, and also ationships of the root system to certain characteristics of the rial part of the tree.

ffmann, G. 1966. [THE COURSE OF DEEP ROOT GROWTH ND SECONDARY ROOT FORMATION IN SOME TREE ECIES.] Arch. Forstw. 15 (8): 825-56. [43 refs. [G.g.ru.e.].]

sy, G. 1965. [STUDIES OF THE ROOTS OF COMMERCIAL PLARS.] Erdo 14 (5): 224-9. [Hu.ru.g.]
posure, on the same site, of the root systems of four cultivars owed that they were recognizably distinctive and illustrated the ltivars' demands on the site.

181.4

rton, K. W., and Hopkins, E. J. 1965. INFLUENCE OF FIRE ON SPEN [POPULUS TREMULOIDES AND P. GRANDIDENTATA] UCKERING. Publ. Dep. For. Can. No. 1095, pp. 19. 14 refs. .e.f.]
is shown that the prevention of suckering through intense burning impractical if not impossible.

181.5

rnes, B. V. 1966. THE CLONAL GROWTH HABIT OF MERICAN ASPENS. Ecology 47 (3): 439-47. [31 refs.]

Blake, G. M. 1964. CLONE IDENTIFICATION AND DELINEATION IN THE ASPENS. Abstr. of thesis, in Dissert. Abstr. 25 (5): 2688. O.R.S.

181.8

Lyr, H., and Hoffmann, G. 1965. [STUDIES OF THE ROOT AND SHOOT GROWTH OF SOME WOODY SPECIES.] Repr. of Silva fenn. 117 (4), pp. 19. 11 refs. [G.] (On sale: Academic Bookstore, Helsinki 10. Price Finnmark 2.)

182 SYNECOLOGY, PLANT SOCIOLOGY

182.5

Goff, F. G., and Zedler, P. H. 1968. STRUCTURAL GRADIENT ANALYSIS OF UPLAND FORESTS IN THE WESTERN GREAT LAKES AREA. Ecol. Monogr. 38 (1): 65-86. [49 refs.]

187 VEGETATION TYPES

Denaeyer de Smet, S., and Duvigneaud, P. 1971. [COAL MINE SPOIL MOUNDS CONSIDERED AS ECOSYSTEMS. CONTRIBUTION NO. 2. PRELIMINARY PHYTOCHEMICAL SURVEY OF SPOIL MOUND NO. 7 OF CHAPELLE-LEZ-HERLAIMONT.] Bull. Soc. Bot. Belg. 104 (2): 323-31. [F.e., 10 ref. OBD]

Solov'eva, P. P. 1968. [RIPARIAN WOODLANDS OF THE TEREK DELTA IN LOWLAND DAGHESTAN.] Nauc. Dokl. Vyss. Skoly (Biol. Nauki), Moskva (12), (84-6). [3 refs. [Ru.] N.L.L.]

2 SILVICULTURE

ahatadze, L. B. 1969. [WAYS OF REHABILITATING THE OWLAND FORESTS OF EASTERN GEORGIA.] Lesn. Hoz. (1), 7-9). [Ru.]

22 SILVICULTURAL SYSTEMS. CONSTITUTION AND COMPOSITION OF STANDS; FORMS OF STAND

222 COPPICE, POLLARDING AND LOPPING SYSTEMS

nspahr, D. W., and Benson, M. K. 1968. MANAGEMENT OF SPEN ON 10- TO 20-YEAR ROTATIONS. J. For. 66 (7): 557-60. 5 refs.]

iordano, E. 1974. [PRELIMINARY NOTES ON SHORT-OTATION COPPICE MANAGEMENT OF POPULUS 'I-214'.] ellulosa e Carta 25 (9): 5-9 [It.f.e.de., 6 ref.]
oplar managed (for production of wood chips) on rotations of 3-5 ears, m.a.i. during the second rotation (6.7-7.1 m^3/ha) was > 50% eater than that during the first rotation.

228 CONSTITUTION AND COMPOSITION OF STANDS; FORMS OF STAND

azire, P., and Buttoud, G. 1974. [RECENT ACTION TAKEN BY HE NATIONAL FOREST FUND TO ASSIST AFFORESTATION.] Revue Forestiere Francaise 26 (5): 391-395 [F.]

23 REGENERATION AND FORMATION OF STANDS

231 NATURAL REGENERATION

arrett, P. W., and Zahner, R. 1964. CLONAL VARIATION IN UCKERING OF ASPEN OBSCURES EFFECT OF VARIOUS LEARCUTTING TREATMENTS. J. For. 62 (10): 749-50. 6 refs.

laini, J. S. 1967. VARIATION IN THE VEGETATIVE PROPAGATION OF POPULUS IN NATURAL POPULATIONS. Abstr. in Bull. col. Soc. Amer. 48 (2): 75-6. [A.P.B.]
tremuloides produces a large quantity of seed but ecologica onditions are unfavourable to germination. Repeated vegetativ production has resulted in the formation of ♂ and ♀ clones. Thi lonal variation is a valuable feature and may be employed in the anagement of natural Aspen stands by encouraging desirable lones that have performed well under a given set of ecological onditions.

Maini, J. S., and Horton, K. W. 1966. REPRODUCTIVE RESPONSE OF POPULUS AND ASSOCIATED PTERIDIUM TO CUTTING, BURNING, AND SCARIFICATION. Publ. Dep. For. Can. No. 1155, pp. 20. [16 refs. [E.e.f.].]

Zahner, R., and DeByle, N. V. 1965. EFFECT OF PRUNING THE PARENT ROOT ON GROWTH OF ASPEN SUCKERS. Ecology 46 (3): 373-5. 6 refs.

232 ARTIFICIAL REGENERATION

232.13

Avanzo, E. 1972. [EARLY EVALUATION OF THE INCREMENT OF SOME CLONES OF POPULUS X EURAMERICANA [P. X 'CANADENSIS'] IN FOUR COMPARATIVE PLANTING TRIALS IN CENTRAL ITALY.] Cellulosa e Carta 23 (1): 37-45. [It.f.e.de., 13 ref.]

Chmielewski, W. 1970. [INVESTIGATIONS ON POPLARS.] Sylwan 114 (3): 7-14. [Pol.ru.e., 3 refs.]
Details given of the performance of P. 'Robusta' grown at three different spacings (278, 556 and 625 trees/ha.), and of the percentage yields of the various assortments as a function of d.b.h.

Damas, C. de. 1973. [THE 1962 PLOT OF [POPULUS] 'I-214' ON THE MEADOW OF LA CHARRIERE A JUMELLES (MAINE-ET-LOIRE).] Revue Forestiere Francaise 25 (2): 125-133 [F., 1 ref.]
The beneficial effect of applying NPK fertilizer at planting time is particularly noteworthy.

Dekanic, I. 1973. [PULPWOOD PRODUCTION BY VARIOUS HYBRID BLACK POPLARS GROWN BY DIFFERENT METHODS.] Topola 17 (98/99) 43-45 [Sh.f.]

Endo, Y. 1965. [GROWING CONDITIONS OF IMPROVED POPLAR.] Wood Ind., Tokyo 20 (12): 6-9. [Jap.] P.R.
Details of diameter growth of 'I-214' which, with a mean diameter of 30 cm. at 7 years, compares favourably with growth in northern Italy.

Fabijanowski, J., Jaworski, A., and Rzeszotko, J. 1974. [EVALUATING THE SUITABILITY OF FOUR POPLAR VARIETIES FOR CULTIVATION IN THE POPRAD VALLEY, AS EXEMPLIFIED BY THE STARY SACZ PLANTATION.] Sylwan 118 (2): 37-45 [Pol.ru.e., 19 ref.]

Hyun, S. K., Hwang, J. W., et al. 1974. THE GROWTH PERFORMANCE OF ITALIAN POPLAR CLONES (POPULUS EURAMERICANA CV. I-214 AND I-476) IN KOREA. Research Report of the Institute of Forest Genetics, Korea No. 11. (13-31). [E.kor., 13 ref.]

Jovanovic, S. 1970. [DETERMINING REGIONS SUITABLE FOR SOME HYBRID POPLARS ON THE ALLUVIUM OF THE MAIN RIVERS IN SERBIA.] Glasnik Sumarskog Fakulteta, Univerzitet u Beogradu No. 36, 176 pp. [Sh.de., 91 ref.]

Sonnaville, P. de. 1964. [IS THE NEW POPLAR 'I-214' worth a trial?] Populier, Wageningen 1 (1): 8-9. [Du.]

Stamenkovic, V., and Miscevic, V. 1970. [DEVELOPMENT AND INCREMENT OF POPLAR PLANTATIONS (CLONE 'I-214') IN THE CRNA REKA VALLEY AT DEBELI LUG.] Sumarstvo 23 (5/6): 21-34. [Serb.g., 6 refs.]

Vasilic, V. 1974. [THE 'ISTRIAN' POPLAR.] Topola 18 (100/101): 97-100 [Sh.e.]

Zameir, I. 1971. [GROWING HYBRID BLACK POPLARS IN TURNU MAGURELE FOREST DISTRICT.] Rev. Padurilor 86 (5): 231-4. [Ro.]
After the clearance of derelict hardwoods on a Rumanian floodplain site and preparatory cultivation of water-melons for 2 years, Populus 'R-16' grew best, with a volume of 165 m^3/ha at 6 years (mean height 21 m), followed by P. 'I-214' and P. 'R-20': P. 'marilandica' grew relatively poorly.

232.315

Lotti, A., Gutierrez de Solanos, V., and Deromedis, R. 1965. [STORAGE OF POPLAR SEED.] Revista de la Facultad de Ciencias Agrarias, Mendoza, Argentina 12 (1): 95-8 + 1 tbl. [6 refs. [Span.span.e.] C.G.B.]
Seed from Populus 'I-214' and P. 'I-455' was stored (a) at 15-20° C. and 40% r.h.; (b) in a refrigerator at 2-4°, and (c) in a deep freeze at −15° after drying in the laboratory climate for 3 days. With (c) germination was good for 1 or 2 years.

232.32

Hadzi-Georgiev, K. 1964. [PRODUCTION OF POPLAR PLANTING STOCK IN NURSERIES AT MRZENCY (GEVGELIJA) [MACEDONIA].] Godisn. Sum. Inst., Skopje 6, 1962-1963, (248-64 + 2 photos). 11 refs. [Maced.ru.] P.R.
Makes recommendations on nursery site and the production of planting stock (rooted cuttings).

Laczay, T. 1973. [EFFECT OF THE POSITION OF A SODA SOIL HORIZON ON THE GROWTH OF HYBRID BLACK POPLAR PLANTS IN THE NURSERY.] Erdo 22 (6): 270-272. [Hu.ru.e.]

232.322

Frison, G. 1967. [MINERAL LOSSES IN POPLAR NURSERIES.] Cellulosa e Carta 18 (12): 10-24. [11 refs. [It.it.e.f.g.].]
It thus appears that the amounts of minerals removed from the nursery are generally similar to those removed with a cereal crop in one or two years respectively, but the amount of Ca required by the Poplars is higher.

Frison, G. 1968. [MINERAL LOSSES IN NURSERIES OF EURO-AMERICAN POPLARS.] Cellulosa e Carta 19 (4): 27-36. [8 refs. [It.it.f.e.g.].]

Giulimondi, G. 1967. [EXPERIMENTS IN FERTILIZING AND SOIL CULTIVATION IN POPLAR NURSERIES.] Proc. 14th Congr. Int. Union For. Res. Organ., Munich 1967 Pt. IV. Sect. 23, (225-37). [13 refs. [F.f.].]
Experiments in a nursery for Populus 'I-214' indicated that best results were obtained when fertilizers were ploughed into the soil to a depth of 50-55 cm. N content of branches and P content of all woody parts showed no correlation with uptake of those elements by the roots.

Giulimondi, G. 1968. [FERTILIZING AND SOIL CULTIVATION TRIALS IN A POPLAR NURSERY.] Pubbl. Cent. Sper. Agric. For., Roma 10 (2): 149-58. [15 refs. [It.it.e.e.].]
Deep working (50-55 cm.) and placement of fertilizers (10-15 cm. gave significantly better growth after 2 years than other treatments. Results of chemical analyses of leaves, stem and branches ar included.

Giulimondi, G. 1972. [PRELIMINARY INVESTIGATION ON THE EFFECTIVENESS OF APPLYING N FERTILIZER TO A POPLAR NURSERY.] Pubblicazioni del Centro di Sperimentazione Agricol e Forestale 11 (2): 145-153 [It.e., 2 ref.]
It is concluded that the demand for nutrients in the raising o Poplars in nurseries is met if N is supplied by growing leguminou plants and applying organic manure and N fertilizer at the beginnin of the second year.

Giulimondi, G., and Duranti, G. 1973. [K FERTILIZER TRIAL IN A POPLAR NURSERY.] Cellulosa e Carta 24 (2): 42-45 [It.f.e.de. 4 ref.]
No appreciable increase in the height or diameter of the K-treated trees was evident, although the uptake of K by these trees wa apparently greater than that by the untreated controls.

Liani, A. 1966. [FOLIAR ABSORPTION OF PHOSPHOROUS IN HYBRID BLACK POPLAR [POPULUS X EURAMERICANA cv 'I-214'] IN THE PRESENCE OF [CHEMICAL] STIMULATORS.] Pubbl. Cent. Sper. Agric. For., Roma 8. (215-29 + 1 plate). [23 refs [It.it.e.e.].]
In investigations on pot plants using P^{32}-labelled solutions, application was more effective on the lower than the upper lea surface.

Liani, A. 1967. EXPERIMENTS ON SULPHUR FERTILIZATION OF POPLARS. Proc. 14th Congr. Int. Union For. Res. Organ. Munich 1967 Pt. II, Sect. 21, (298-317). [21 refs. [E.e.].]
Describes an Italian investigation using rooted cuttings of Populus 'I-214' in pots. Height and diameter increment both increased with increasing doses of (radioactive) S applied to a poor, acid, unfertilized soil.

Liani, A. 1967. [FURTHER RADIOMETRIC RESEARCH ON P UPTAKE IN POPLAR.] Pubbl. Cent. Sper. Agric. For., Roma 9 (3): 163-72. [12 refs. [It.it.e.e.].]

Liani, A., and Lubrano, L. 1966. [PRELIMINARY EXPERIMENTS IN FOLIAR TREATMENT WITH PHYTOHORMONES ON YOUNG POPLARS.] Pubbl. Cent. Sper. Agric. For., Roma 9 (1): 57-68. [12 refs. [It.it.e.e.] 8 tbls.]

232.324

Herpka, I., and Markovic, J. 1974. [DEPENDENCE OF THE PRODUCTION OF TWO-YEAR POPLAR PLANTS ON THE SIZE OF THE ROOTED CUTTING.] Topola 18 (102): 3-11 [Sh.e., 9 ref.]
The best material consists of 1-year rooted cuttings that are 2 cm in diameter at the root-collar and 2-3 m tall before cutting back. The cut shoots from the 1-year plants are again used for cuttings.

232.325

Magnani, G. 1970. [WEEDING IN NURSERIES OF NEWLY PLANTED POPLARS: PRELIMINARY TRIALS.] Cellulosa e Carta 21 (5): 97-101. [It.f.e.g., 1 ref.]
The best results as regards both weed control and growth of the Poplar were obtained with Herbidal 'total' (50% aminotriazole) + Zealan (50% linuron) at 6 + 3 kg./ha. or diphenamid at 7-8 kg./ha.

Magnani, G. 1972. [CHEMICAL WEEDING TRIALS IN NEWLY PLANTED POPLAR NURSERIES.] Cellulosa e Carta 23 (2): 27-34. [It.f.e.de.]

232.328

Alonzo, A. E., and Sancho, R. 1964. [INFLUENCE OF POSITION IN THE SHOOT IN THE CHOICE OF CUTTINGS OF SALICACEAE.] Idia: Suppl. No. 12, (15-22). 3 refs. [Span.]
Position in the shoot is considered more important than diameter of cutting. The study has special application in the Argentine Delta, where close spacing, e.g. 1.5 X 3 m., is used to suppress grasses and rushes.

enson, M. K., and Schwalbach, D. E. 1970. TECHNIQUES FOR OOTING ASPEN ROOT SPROUTS. Tree Plant. Notes 21 (3): -4. [3 refs.]

rison, G. 1970. [COMPARATIVE TRIALS ON THE ROOTING ND GROWTH OF YOUNG POPLARS OBTAINED BY LIFTING OOTED PLANTS AND BY CUTTING OFF STEMS AT SOIL EVEL.] Cellulosa e Carta 22 (12): 25-33. [It.f.e.de.]

ejmanowski, S. 1970. [EFFECT OF THE AGE OF PARENT TOOLS ON THE QUALITY OF POPLAR CUTTINGS.] Prace st. Bad. Lesn. No. 381/384, (3-100). [Pol.ru.e., 81 refs.]

uzmanovic, U. 1968. [DIAMETER OF CUTTINGS – AN IMPORANT FACTOR IN THE PRODUCTION OF [POPLAR] LANTS.] Topola, Beograd 12 (67/68): 11-3. [Serb.f.]

ntos, G., Pantos, G., and Takats, T. 1964. [THE EFFECTS OF ITAMINS, ANTIBIOTICS, TRACE ELEMENTS, AND ETABOLIC PRODUCTS OF MICROBIAL ORIGIN ON OOTING AND SHOOT GROWTH OF CUTTINGS OF POPULUS 214' AND P. X ROBUSTA.] Erdesz. Faipari Egyetem tud. Kozl., pron (1), (65-79). 13 refs. [Hu.hu.ru.g.]

uggeri, C. 1966. [ANATOMICAL OBSERVATIONS ON ROOT ORMATION OF POPULUS 'I-214' IN CONTROLLED CONITIONS.] Pubbl. Cent. Sper. Agric. For., Roma 9 (1): 1-10 + 4 ates. [10 refs. [It.it.e.e.] 1 tbl.]
study of the early stages of development of root primordia and e changes as the plant grows older.

232.329

cLean, M. M. 1968. PROPAGATION OF TREES BY TUBE ECHNIQUE. Proc. Int. Pl. Propag. Soc., Toronto 18, (303-9). E.M.B.]

232.4

abielski, S. 1969. [THE EFFECT OF VARIOUS FACTORS ON HE SUCCESS OF PLANTING OUT IN POPLARS.] Bull. Serv. ult. Etud. Peuplier et Saule (33-53). [F.]
n favourable sites, root pruning had no ill effects on rooting and n height growth; on poorer sites total root removal was harmful; nd on all sites this treatment (but not root shortening which gave etter results than the retention of long roots) reduced diameter rowth. Deep planting was generally beneficial. Laboratory tests ndicated that a tissue water content of 90-100% of dry weight was thal; for good results a content of 130 to 150% is required. rovided that storage conditions were good, autumn lifting was not nferior to spring lifting. On well watered sites, late planting (ca. 10 lay) was as successful as planting in early spring.

232.41

larkovic, J. 1974. [IMPORTANCE OF THE CLASS (SIZE) OF 2/3 LANTS FOR WOOD VOLUME PRODUCTION BY POPULUS -214'.] Topola 18 (100/101): 87-95. [Sh.e.]

imon, M. 1974. INFLUENCE OF PLANTING MATERIAL AND LANTING METHOD ON QUALITY YIELD OF POPLAR LANTATIONS ON SANDY SITES. Erdeszeti Kutatasok 69 (2): 11-123. [E.]

232.42

arneoud, C., and Bonduelle, P. 1971. [RESULTS OF FERTIIZER TRIALS ON POPULUS 'I-214' IN FRANCE.] Rapp. Ass. or.-Cell. (135-86). [F.e.de., 8 ref.]
rials of fertilizer applications at planting time suggest that only NP ertilizer is always effective; the action of K, Ca or Mg is very ariable and unpredictable.

rison, G. 1973. [EFFECT OF DEEP PLANTING ON THE OOTING AND GROWTH OF YOUNG POPLARS UNDER IFFERENT SOIL AND CLIMATIC CONDITIONS.] Cellulosa e arta 24 (1): 3-18. [It.f.e.de., 15 ref.]

lerpka, I. 1974. [EVALUATION OF METHODS OF ESTABISHING POPLAR (CLONE 'I-214') ON SANDY ALLUVIAL OIL OF THE DANUBE.] Topola 18 (100/101): 53-63 [Sh.e., 5 ef.]

Herpka, I., Markovic, J. T., and Zivanov, N. 1972. [STUDY OF THE DISTRIBUTION OF THE BIOMASS OF THE ROOT SYSTEM OF POPULUS X EURAMERICANA CL. 'I-214' WITH NORMAL AND DEEP PLANTING.] Topola 16 (93/94): 3-17. [Sh.e., 12 ref.]
Two-year-old plants of Populus 'I-214' were planted on six mainly sandy sites in holes 80 X 80 X 80 cm, and in holes of 10 cm diameter bored to a depth of 2-3 m to reach a permanent supply of water.

Simon, M. 1965. [DEEP PLANTING POPLARS.] Erdo 14 (12): 529-35. 6 refs. [Hu.ru.g.]
In deep-planted Poplars (cv. 'I-214'), roots developed vigorously at great depths and continued growing all through the winter at depths of 300 cm. where the temperature of the ground water (at ca. 400 cm.) was 10° C.

232.43

Curro, P., Sertmehmetoglu, Z., and Acar, O. 1965. [INVESTIGATIONS ON THE EFFECT OF SPACING [ON] POPULUS X EURAMERICANA CV. 'I-214'.] Tek. Yay. Kavak. Arast. Enst., Izmit No. 2, pp. 19. [Turk.F.]
The c.a.i. of 20 sample trees of 8-year-old Populus 'I-214' grown at 4 spacings was determined by stem analysis, and volume/age regressions and optimum rotations were calculated.

Harmath, B., and Szodfridt, I. 1967. [A SPACING TRIAL WITH THE POPLAR CLONE 'I-214'.] Erdo 16 (1): 30-4. [Hu.ru.g.] [1 gph. 3 tbls.]

Herpka, I. 1965. [PRODUCTION OF WOOD ON A 3-YEAR ROTATION.] Topola, Beograd 9 (48/49): 16-29. 9 'refs. [Serb.serb.e.]

Peno, D., and Mirkovic, D. 1967. [DEPENDENCE OF THE YIELD OF A [POPULUS] 'I-214' PLANTATION ON THE SOIL AND PLANTING DENSITY.] Jelen, Beograd (6), (5-36). [4 refs. [Serb.ru.e.].]

Prevosto, M. 1965. [GROWTH AND YIELD OF THE HYBRID BLACK POPLAR 'I-214' IN RELATION TO SPACING AND ROTATION IN VARIOUS SITES IN THE LOMBARDY-PIEDMONT PLAIN.] Pubblicazione dell' Ente Nazionale per la Cellulosa e per la Carta, Roma pp. xii + 160 + 2 maps. 38 refs. [It.it.f.e.g.]

Prevosto, M. 1967. TECHNICAL AND ECONOMIC RESULTS OF SEVERAL DIFFERENTLY SPACED POPLAR STANDS IN RELATION TO THE VARIATIONS IN PRICES OF TIMBER BETWEEN 1962 AND 1966. Transl. Dep. For. Can. No. 127, 1967. pp. 24 + 5 tbls. [Transl. by L. Fratta from Cellulosa e Carta 18 (2): 27-42. [Limited distribution.]

Proni, G., and Prevosto, M. 1974. [THE PROBLEM OF SPACING IN SPECIALIZED POPLAR STANDS IN THE LOMBARDY-PIEDMONT PLAIN.] Cellulosa e Carta 25 (9): 28-32. [It.f.e.de.]
The results show that: the average annual volume of usable wood per ha. reaches its maximum in stands at 2500 trees/ha, planted with 2-year-old rooted saplings and managed on a 4-year rotation.

Smith, J. H. G., and Blom, G. 1970. POPLAR SPACING TRIALS SHOW WAY TO GAINS IN WOOD YIELD. Canad. For. Ind. 90 (7): 40-1. [6 refs.]

233 AFFORESTATION

Giordano, E. 1968. [AN INTERESTING EXAMPLE OF INDUSTRIAL PLANTATIONS IN CALABRIA.] Cellulosa e Carta 19 (4): 37-44. [2 refs. [It.f.e.g.].]

Prego, A. J., et al. 1965. [DUNE PLANTING IN THE SEMI-ARID PAMPAS. PART II.] Idia: Suppl. No. 16, (75-92) [18 refs. [Span.] (Suplemento Forestal No. 2).]
Planting stock was mainly setts 4-6 m. long of Populus X 'canadensis' cv. 'I-214', but trials were also made with P. deltoides cvs. 'I-63', 'I-64' and 'I-72'. A planting depth of 1·5 m., however, gave 90% take.

Prego, A. J., Rial Alberti, F., and Prohaska, F. J. 1964. [DUNE PLANTING IN THE SEMI-ARID PAMPAS. PART I.] Idia: Suppl. No. 12, (73-82). 5 refs. [Span.]

237 AMELIORATION OF FOREST SITES

Dimitrov, K., and Denev, D. 1973. [ECOLOGICAL AND PHYSIOLOGICAL PREREQUISITES FOR IRRIGATION IN POPLAR PLANTATIONS.] Gorskostopanska Nauka 10 (3): 3-14. [Bulg.-ru.e., 9 ref.]

Garbaye, J., and Leroy, P. 1974. [FERTILIZATION, CHEMICAL WEEDING AND SOIL WORKING IN A PLANTATION OF [POPULUS] 'I-214'.] Revue Forestiere Francaise 26 (2): 139-145. [F., 2 ref.]
Of the fertilizers tested (N, P, K, Ca), only N had a beneficial effect on growth. In conjunction with soil working, surface application of N for 3 successive years after planting gave an increase in girth increment of 43% during the first 5 years.

Jaime Fanlo, F., and Chardenon, J. 1971. [GROWING POPLAR UNDER IRRIGATION.] Bull. Serv. Cult. Etud. Peuplier et Saule (28-35). [F.]
The article is based mainly on observations and the results of work done in Turkey.

Pantos, G., Kerenyi, E., and Beller, P. 1973. [UTILIZATION OF LIQUID PIG-MANURE WITH SPECIAL REFERENCE TO POSSIBILITIES OF [INCREASING] WOOD PRODUCTION.] Erdeszeti es Faipari Egyetem Tudomanyos Kozlemenyei No. 1, 75-102. [Hu.ru.e.de., 12 ref.]

Prevosto, M. 1972. [EFFECTS OF IRRIGATION ON THE VOLUME PRODUCTION AND ECONOMIC RETURN FROM A POPLAR STAND UNDER INTENSIVE MANAGEMENT ON AN ESTATE IN THE PIEDMONT PLAIN.] Cellulosa e Carta 23 (4): 3-22 [It.f.e.de., 8 ref.]

Simon, M. 1971. [GROWING POPLARS WITH SEWAGE IRRIGATION.] Erdo 20 (7): 295-300. [Hu.ru.e.]

Tosi, C. 1966. [APPLICATION OF MINERAL FERTILIZERS TO POPLAR PLANTATIONS.] Ital. agric. 103 (10): 921-41. [21 refs. [It.] E.M.B.]
Describes three fertilizer trials on Populus 'I-214' and P. 'I-B2' plantations near Turin.

Viart, M. 1965. [FERTILIZING POPLARS.] Bull. Serv. Cult. Etud. Peuplier et Saule, Paris (2), (1-37). 13 refs. [F.]
Chief results confirm the beneficial effect of P, particularly in the presence of K (especially as sulphate), and a lack of response to nitrochalk alone.

238 TIMBER PLANTATION CROPS REQUIRING SPECIAL TREATMENT

Barneoud, C. 1970. [SOIL WORKING IN POPLAR PLANTATIONS.] C. R. Ass. For.-Cell. 1969, (153-72). [F.e.g.]

Clonaru, A. 1968. [POTENTIALS OF REED SWAMPS FOR THE CULTIVATION OF POPLARS AND WILLOWS.] [Docum.] 13th Sess. Int. Poplar Comm., Montreal 1968 No. FO:CIP/13/48, pp. 5. [F.f.]
Early results are promising and suggest that it is possible to maintain low ground-water levels, that soil cultivation to a depth of 40 cm. is adequate, and that the regrowth of reeds is strongly impeded by soil cultivation and tending.

Clonaru, A. 1972. [STUDIES ON THE USE OF CERTAIN REED-GROWING AREAS PROTECTED BY DAMS [IN THE DANUBE DELTA] FOR PLANTATIONS OF POPLAR AND WILLOW.] Bulletin de l'Academie des Sciences Agricoles et Forestieres No. 1, 181-189 [F.]

Famiglietti, A. 1973. [THE PRODUCTIVITY OF POPLAR PLANTATIONS IN THE VENETO.] Annali del Centro di Economia Montana delle Venezie 8, 1-47 [It.e., 30 ref.]

Herpka, I., and Markovic, J. T. 1971. [WOOD PRODUCTION OF EIGHT HYBRID POPLARS ON A SHORT ROTATION.] Topola 15 (83/85): 23-31. [Sh.e., 5 ref.]
Compares the volume yield of 8 clones, with an initial spacing of 2 X 2 m, on a 6-year rotation in Yugoslavia

Kohan, S. 1969. [PROBLEMS OF RAISING POPULUS 'ROBUSTA' IN STANDS ON THE E. SLOVAKIAN PLAIN.] Lesn. Cas. 15 (3): 193-210. [Slovak.ru.e.g., 13 refs.]
Assesses the performance and condition of stands aged 6-26 years, mostly on heavy loam soils and alluvium.

Kohan, S. 1972. [RESULTS SO FAR IN GROWING POPULUS 'I-214' IN E. SLOVAKIA.] Lesnicky Casopis 18 (2): 137-148. [Sk.ru.e.de., 11 ref.]

Kuzmanovic, U. 1973. [SOME RESULTS OF INVESTIGATIONS ON PLANTATIONS OF HYBRID POPLAR, CLONE I-214,, ON THE ALLUVIUM OF THE VELIKA MORAVA.] Topola No. 95/96, 35-43 [Sh.e., 7 ref.]
Data are given on volume increment and on the economics of pulpwood production on a very short rotation.

Marmol, L. A. 1970. [POPLAR-GROWING IN THE '25 DE MAYO' DISTRICT, BUENOS AIRES PROVINCE, ARGENTINA.] Rev. for. argent. 14 (1): 7-13. [Span., 6 refs.]

Miklos, S. 1972. [GROWING POPLAR PLANTATIONS ON THE SANDY AREA BETWEEN THE DANUBE AND THE TISZA [IN HUNGARY].] Topola 16 (93/94): 19-32 [Sh.e., 20 ref.]
Planting in deep pits or deep bore-holes is best, at a spacing of 6 X 6 m.

Petrov, M. 1970. [POSSIBILITIES OF GROWING CERTAIN POPLARS ON LEACHED CHERNOZEMS.] Gorsko Stopanstvo 26 (5): 21-4. [Bulg., 2 refs.]

Sekawin, M., and Prevosto, M. 1973. [EFFECT OF TILLAGE AND INTER-CROPPING ON THE TECHNICAL AND ECONOMIC PERFORMANCE OF A POPLAR STAND LOCATED IN THE PIACENZA REGION.] Cellulosa e Carta 24 (8): 3-18 [It.f.e.de., 6 ref.]
It consists of a comparison between five silvicultural treatments. Intercropping as compared with cultivation alone has had no effect on tree growth, and that cultivation for the first four years is advantageous.

Simon, M. 1965. [EVENING OUT SITE VARIATIONS ON SANDS BY MEANS OF INTENSIVELY MANAGED PLANTATIONS ESTABLISHED BY DEEP PITTING.] Erdo 14 (5): 210-7. [Hu.ru.g.]

Simon, M. 1972. [PLANTING POPLARS ON SANDY SITES BY DEEP PITTING OR BORING.] Erdeszeti Kutatasok 68 (2): 49-59. [F.]

Sonnaville, P. de. 1973. [CAN THE ROTATION FOR POPLARS BE REDUCED TO 20 YEARS OR LESS?] Populier 10 (3): 54-55. [Nl.]

Taranu, N. 1970. [CLONES AND SPACING IN POPULUS X 'CANADENSIS' PLANTATIONS FOR PULPWOOD PRODUCTION.] Rev. Padurilor 85 (6): 308-9. [Rum.]
Presents the results of a Rumanian experiment in planting two clones ('R-18' and 'I-214') at four spacings (4 X 2, 4 X 4, 5 X 5 and 6 X 6 m.)

24 TENDING OF STANDS AND TREES

242 THINNINGS

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Details are given of the performance of the plantations up to 16 years.

Giordano, E., and Avanzo, E. 1969. [OBSERVATIONS ON THINNING OF A POPULUS X EURAMERICANA "I-214" PLANTATION.] Cellulosa e Carta 20 (3): 55-58 [It.]

245 TENDING OF TREES

Bonduelle, P. [1972.] [THEORETICAL AND PRACTICAL STUDY ON THE PRUNING OF POPULUS 'I-214'.] In Rapport Annuel, Association Foret-Cellulose 1971, 293-345. [F.e.de., 3 ref.]
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26 COMBINATIONS OF FORESTRY WITH AGRICULTURE

263 IRRIGATED FORESTS

Burgos, J. C. 1966. [GROWTH STUDY IN A PLANTATION OF POPULUS 'I-214' IN TUNUYAN, MENDOZA, ARGENTINA.] Rev. for. argent. 10 (4): 128-34. [3 refs. [Span.e.].]

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4 FOREST INJURIES AND PROTECTION

41 GENERAL TECHNIQUE OF FOREST PROTECTION. TYPES OF INJURY

Hadzi-Georgiev, K., and Popnikola, N. 1971. [STEM CRACKS IN POPLAR IN MACEDONIA.] Topola 15 (83/85): 49-54. [Sh.e., 6 ref.]

Kiss, L. 1968. [THE EFFECT OF INSECTICIDES ON POPLAR CUTTINGS.] Erdo 17 (1): 26-9. [Hu.ru.e.]

42 INJURIES FROM INORGANIC AGENCIES (EXCLUDING FIRES)

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Kolster, H. W. 1966. [HIGH WATER AND POPLARS.] Populier, Wageningen 3 (2): 31-2. [Du.]

Mate, K., and Balsay, E. 1966. [FOREST PLANTATIONS IN THE HANSAG REGION REVIEWED IN THE LIGHT OF THE FLOODS OF 1965.] Erdo 15 (2): 53-9. [Hu.ru.e.]
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44 DAMAGE BY HARMFUL PLANTS. VIRUS DISEASES

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Varga, F. 1969. [ON THE NUTRITIONAL BIOLOGY OF LYMANTRIA DISPAR AND ITS RELATION TO MASS OUTBREAKS.] Erdesz. Faipari Egyetem tud. Kozl. (1), (71-82). [Hu.ru.e.g., 4 refs.]

5 FOREST MENSURATION

52 MEASUREMENTS OF STEM DIMENSIONS AND VOLUME OF TREES, STANDS, FORESTS AND TIMBER

523 BARK (INCLUDING BARK INCREMENT)

Szodfridt, I. 1969. [THICKNESS AND PERCENTAGE OF BARK, AND THE INDUSTRIAL WOOD ASSORTMENTS OF POPULUS 'I-214'.] Erdo 18 (6): 265-8. [Hu.ru.e.]

524 DETERMINATION OF THE VOLUME OF TREES AND STANDS

Giordano, G., and Ghisi, G. 1966. [WOOD VOLUME TABLES FOR POPULUS CV. I-214 GROWN ON THE SAICI ESTATE, TORVISCOSA, UDINE.] Topola, Beograd 10 (55/56): 15-8. [Serb.]

524.1

Curro, P., and Ghisi, G. 1968. [VARIATION OF STEM FORM FACTOR IN POPULUS 'I-214'.] Pubbl. Cent. Sper. Agric. For., Roma 9 (4): 291-8. 3 refs. [It.it.e.]

Mendiboure, P. [1972.] [FORM EQUATIONS: METHOD AND FIRST RESULTS.] Report Annuel, Association Foret-Cellulose 1971, (37-61). [F.e.de., 11 ref.]

524.3

Barneoud, C., and Bonduelle, P. 1969. [STANDING VOLUME AND YIELD OF PLANTATIONS OF POPULUS 'I-214' IN EASTERN FRANCE.] C.R. Ass. For.-Cell., Paris 1968, (121-53). [1 ref. [F.e.g.].]

Barneoud, C., and Bonduelle, P. 1970. [STANDING VOLUME AND YIELD OF PLANTATIONS OF POPULUS 'I-214' IN EASTERN FRANCE.] C.R. Ass. For.-Cell. 1969, (173-207). [F.e.g., 1 ref.]
Surveys of Poplar stands continued and data are given on form quotients, stem analyses, the effects of pruning, and yield.

525 VOLUME BY ASSORTMENTS. MERCHANTABLE VOLUME

Landt, E. F. 1974. ASPEN [POPULUS GRANDIDENTATA] VOLUME TABLES FOR FURNITURE-TYPE, FLAT, 4/4-INCH DIMENSION. USDA Forest Service Research Note, North Central Forest Experiment Station No. NC-166, 2 pp. [E., 1 ref.]
Tables are given to show the yield of 1-in dimension stock obtained from stems cut to 6 in top diameter.

53 SPECIAL MEASUREMENTS OF TREES AND STANDS (CROWN DIMENSIONS, STAND DENSITY, ETC.)

Satter, L. D., Baker, A. J., and Millett, M. A. 1970. ASPEN SAWDUST AS A PARTIAL ROUGHAGE SUBSTITUTE IN A HIGH CONCENTRATE DAIRY RATION. Repr. from Journal of Dairy Science 53 (10): 1455-60. [25 ref. PR]
In an experiment in the USA, ca. 30% of P. grandidentata sawdust was incorporated in pelleted concentrates fed to dairy cows. The sawdust proved effective as a partial roughage substitute for hay.

54 ASSESSMENT OF SITE QUALITY

Hellum, A. K., and Zahner, R. 1966. THE FROND SIZE OF BRACKEN FERN ON FORESTED OUTWASH SAND IN NORTHERN LOWER MICHIGAN. Proc. Soil Sci. Soc. Amer. 30 (4): 520-4. [8 refs.]

Munkacevic, V. 1967. [PRODUCTIVITY OF THE SOIL IN PLANTATIONS OF POPULUS 'I-214' AT BARANJA.] Jelen, Beograd (6), (45-81). [26 refs. [Serb.ru.e.e.].]
Determination of site class on the basis of mechanical structure, parent material, and degree of development of the soil, showed that the first soil group provided the best site classes and that the numerical 'soil values' developed by the author corresponded with the volume m.a.i. of the plantations.

Shetron, S. G. 1969. VARIATION OF FOREST SITE PRODUCTIVITY AMONG SOIL TAXONOMIC UNITS IN NORTHERN LOWER MICHIGAN. Abstr. of thesis, in Dissert. Abstr. int. 30B (5): 1986. [Order No. 69-18,109, pp. 187. O.R.S.]

Shetron, S. G. 1972. FOREST-SITE PRODUCTIVITY AMONG SOIL TAXONOMIC UNITS IN NORTHERN LOWER MICHIGAN. Soil Science Society of America Proceedings 36 (2): 358-363. [E., 21 ref.]

Zahner, R., and Crawford, N. A. 1965. THE CLONAL CONCEPT IN ASPEN SITE RELATIONS. In Forest soil relationships in North America. Oregon State University Press, Corvallis, Ore. pp. 229-43. [18 refs.]
Measurements of P. grandidentata in stands throughout northern Lower Michigan showed that all dominant and co-dominant trees within a clone had the same general height/age relationship.

56 INCREMENT; DEVELOPMENT AND STRUCTURE OF STANDS

Fakirov, V. 1969. [GROWTH AND YIELD OF POPLAR PLANTATIONS ON DRY (NON-TYPICAL) POPLAR SITES.] Gorsko Stopanstvo 25 (7): 1-7. [Bulg.]

Szodfridt, I. 1970. [THE YIELD OF POPULUS 'I-214'.] Erdo 19 (1): 20-3. [Hu.ru.e.]

Tuset, R., and Garcia, R. 1969. [TIMBER PRODUCTION OF POPULUS 'I-154'.] Boletin, Facultad de Agronomia, Universidad de la Republica, Montevideo No. 107, pp. 12. [4 refs. [Span.span.e.].]

561 INCREMENT IN HEIGHT, DIAMETER, BASAL AREA, FORM AND QUALITY

Brace, L. G. 1966. RADIAL SHRINKAGE AND SWELLING OF INCREMENT CORES. For. Chron. 42 (4): 387-9. [6 refs.]

569 MISCELLANEOUS

Hirai, S., and Aizawa, E. 1966. [STUDIES ON THE WEIGHT GROWTH OF FOREST TREES. VIII. TWO ARTIFICIALLY PLANTED POPULUS SPECIES.] Bull. Tokyo Univ. For. No. 62 (189-96). [7 refs. [Jap.jap.e.e.].]

6 FOREST MANAGEMENT

65 SPECIAL BUSINESS PROBLEMS OF TIMBER-GROWING

Prevosto, M. 1967. [TECHNICAL AND ECONOMIC RESULTS OF SOME POPLAR PLANTATIONS AT DIFFERENT SPACINGS IN RELATION TO VARIATIONS IN THE PRICE OF POPLAR TIMBER BETWEEN 1962 AND 1966.] Cellulosa e Carta 18 (2): 27-42. [7 refs. [It.it.f.e.g.].]

651 CALCULATION OF COSTS, ETC.

Sertmehmetoglu, Z., Acar, O., and Birler, A. S. 1972. SOME INVESTIGATIONS ON FINANCIAL MATURITY OF POPLAR PLANTATIONS APPLIED TO CULTIVATION OF P. X EURAMERICANA CV. 'I-214'. Izmit, Turkey, Poplar and Fast Growing Trees Research Institute [Kavakcilik Arastirma Enstitusu]. 24 pp. [E., 14 ref. Translated from Turkish.]

66 COSTING OF LOGGING OPERATING

Noreen, P. A., and Hughes, J. M. 1968. SOME ECONOMIC GUIDES FOR ALTERNATIVE USES OF ASPEN LOGS. Tech. Bull Minn. Agric. Exp. Sta. No. 260, pp. 9. [14 refs.]
A comparative study, based on N. American data, of conversion returns for P. tremuloides and P. grandidentata for pulpwood, sawn timber and plywood veneers for a range of log diameters.

8 FOREST PRODUCTS AND THEIR UTILIZATION

81 WOOD AND BARK: STRUCTURE AND PROPERTIES

810 GENERAL INFORMATION ON WOODS

Erdelyi, G., and Wittmann, G. 1974. [INDUSTRIAL UTILIZATION OF HYBRID BLACK POPLARS GROWN IN HUNGARY.] In Faipari Kutatasok 1973, pp. 109-123 [Hu.ru.e.de., TRADA]

Mutibaric, J. 1966. [CHARACTERISTICS OF THE WOOD OF POPULUS CV. I-214.] Topola, Beograd 10 (57/58): 33-5. [5 refs. [Serb.e.] 1 photo.]
Surveys foreign literature and presents some results from original research on mechanical properties and the use of the wood for slicing and peeling, and for paper-making, concluding that wood from trees 10-13 years old provides good raw material for industry.

811 STRUCTURE. IDENTIFICATION

811.1

Georgievski, Z., and Stefanovski, V. 1968. [STUDY ON THE ANATOMICAL ELEMENTS (FIBRES AND VESSELS) OF POPULUS REGENERATA AND CLONE I-214.] God. Zborn. Zemj.-Sum. Fak. Univ. Skopje (Sum.) No. 22, (123-39). [Maced.f., 5 refs.]

Kishima, T. 1966. [REVIEW OF TYLOSIS FORMATION IN HARDWOOD VESSELS.] Wood Res., Kyoto No. 37. (1-5). [13 refs. [Jap.].]

Necesany, V. 1969. THE EFFECT OF SOME GROWTH SUBSTANCES ON THE CELL WALL STRUCTURE. Bull. Int. Ass. Wood Anatomists (1), (1-8 + 4 figs.). [16 refs.]
Effect of the growth substances IAA, GA_3, kinetin and TIBA (three different concentrations each) on the thickness of primary-wall microfibrils and on the length of libriform wood fibres of fast-growing Populus 'I-214,' has been shown to be the same as in tissue culture of the Vinca rosea crown-gall, but at concentrations higher by three orders of magnitude.

811.2

Perem, E. 1964. TENSION WOOD IN CANADIAN HARDWOODS. Publ. Dep. For. Can. No. 1057, pp. 38. 13 refs. [E.e.f.]
Tension wood was studied in samples from leaning stems of P. tremuloides, P. grandidentata, Betula papyrifera, Tilia americana and Ulmus americana. Except in the case of T. americana, tension wood was characterized by the presence of gelatinous fibres.

811.7

Evert, R. F., and Derr, W. F. 1964. CALLOSE SUBSTANCE IN SIEVE ELEMENTS. Amer. J. Bot. 51 (5): 552-9. [30 refs. O.B.D.]

Evert, R. F., and Derr, W. F. 1964. SLIME SUBSTANCE AND STRANDS IN SIEVE ELEMENTS. Amer. J. Bot. 51 (8): 875-80. [20 refs. O.B.D.]
Studies of the secondary phloem of Acer negundo, Juglans nigra, Populus grandidentata, Prunus serotina, Robinia pseudoacacia and Tilia americana showed that slime is not normally dispersed throughout the vacuole of mature sieve elements, but occurs in the form of discrete strands traversing the cell and running from cell to cell through the sieve-plate pores.

Fillo, Z. 1969. [ANATOMICAL CHARACTERISTICS OF THE BARK OF HYBRID POPLAR CULTIVARS.] Faip. Kutatas (189-99). [Hu.ru.e.g., 4 refs. P.R.]

812 PHYSICAL AND MECHANICAL PROPERTIES

Acar, O. 1972. [SOME TECHNOLOGICAL PROPERTIES OF THE WOOD OF POPULUS X EURAMERICANA CV. 64.H COMPARED WITH THOSE OF THE CLONE I-214.] Annual Bulletin, Poplar and Fast Growing Forest Trees Research Institute, Izmit No. 7, 1-68. [Tr] From review in Holzzucht 28, 40. De.
The wood, derived from trial plantings established in 1960, was heavier and stronger than that of P. 'I-214'; it increased in density and dimensional stability with increasing height in the stem.

Duran, F. 1972. [THE PHYSICAL PROPERTIES OF POPULUS X

'CANADENSIS' CV. 'I-154': STUDY OF THEIR VARIATION.] Boletin del Departmento Forestal, Uruguay No. 18, 1-7 + 3 fig. [Es.e., 9 ref.]
Moisture content increased from the bark to the pith, and decreased from the lower to the upper part of the stem. Density decreased from bark to pith. No significant differences in other properties, such as shrinkage, were found.

Erdelyi, G., and Wittmann, G. 1969. [THE PHYSICAL AND MECHANICAL CHARACTERISTICS OF HYBRID BLACK POPLARS GROWN IN HUNGARY.] Faip. Kutatas. (179-84). [Hu.ru.e.g., 2 refs. P.R.]
Density and strength decreased in the order: Populus 'Robusta', P. 'Marilandica', P. 'Serotina' and P. 'I-214'.

812.2

Martin, R. E. 1967. INTERIM EQUILIBRIUM MOISTURE CONTENT VALUES OF BARK. For. Prod. J. 17 (4): 30-1. [6 refs.]

812.3

Curro, P. 1972. [VARIATIONS OF BASIC DENSITY IN [WOOD OF] POPULUS X EURAMERICANA [P. X CANADENSIS].] Cellulosa e Carta 23 (3): 41-49. [It.f.e.de., 6 ref.]
Variations in the basic density (oven-dry weight/fresh volume) of the wood of P. 'I-214' and P. 'I-488' as a function of age and height were investigated by multiple regression methods.

Markovic, J. 1973. [CHANGE IN SPECIFIC GRAVITY OF THE WOOD OF POPULUS 'I-214' GROWN UNDER TWO REGIMES DIFFERING AS REGARDS AGE AND HEIGHT OF THE STEMS.] Topola 17 (98/99): 25-33. [Sh.e., 13 ref.]

812.8

Cantin, M. 1965. THE MACHINING PROPERTIES OF 16 EASTERN CANADIAN WOODS. Publ. Dep. For. Can. No. 1111, pp. 27. [E.e.f.]

813 WOOD CHEMISTRY

Haas, B. R., and Kremers, R. E. 1964. THE PECTIC SUBSTANCES AS AN INDEX TO THE CHEMISTRY OF WOOD FORMATION. Tappi 47 (9): 568-73. [20 refs.]

815 EFFECT OF GROWTH FACTORS ON STRUCTURE AND PROPERTIES

Fillo, Z., Kiss, G. [Kiss, M.] 1974. [COMPARATIVE TESTS ON OLD AND JUVENILE WOOD OF HYBRID POPLARS GROWN IN HUNGARY.] In Faipari Kutatasok 1973, pp. 233-246 [Hu.ru.e.de., 8 ref. TRADA]
Measurements were made of the ring width and early-wood/late-wood ratio in successive annual rings (at b.h.) in 4-year-old and 12-year-old stems of Populus 'Robusta' and P. 'I-214' grown under similar conditions. The sp.gr. and fibre length were also measured in the 12-year-old stems and simple strength properties were determined on the juvenile cores and the outer wood.

Julio, A. G. 1965. [VARIATIONS IN FIBRE LENGTH AND WOOD DENSITY IN POPLAR (POPULUS NIGRA EV. ITALICA, P. 'I-154', and P. 'I-214'.] Inf. tec. Inst. For., Santiago No. 21, (40-4). [14 refs. Span.span.]
Fibre length was highly correlated with distance from pith and with height in the stem. Correlations between wood density and position in stem, wood density and tree diameter, fibre length and tree diameter, and fibre length and species, were significant but not important.

Markovic, J. 1974/75. [THE DIMENSIONS OF WOOD FIBRES AND THE SPECIFIC GRAVITY OF THE WOOD PRODUCED BY TWO DIFFERENT SILVICULTURAL REGIMES IN RELATION TO AGE AND HEIGHT IN THE [POPLAR] CLONE 'I-214'.] Topola 18/19 (103/106): 135-150. [Sh.e.ru.]

Smith, J. H. G., and Rumma, U. 1971. SPECIFIC GRAVITY AND FIBER LENGTH OF HYBRID POPLAR. J. For. 69 (1): 34. [9 refs.]

82 CONVERSION, SHAPING, ASSEMBLY AND FINISHING OF WOOD: GENERAL

Erickson, J. R. 1972. THE MOISTURE CONTENT AND SPECIFIC GRAVITY OF THE BARK AND WOOD OF NORTHERN PULPWOOD SPECIES. USDA Forest Service Research Note, North Central Forest Experiment Station No. NC-141, 3 pp. [E., 2 ref.]

83 TIMBER MANUFACTURING INDUSTRIES AND PRODUCTS

Haygreen, J. G. 1970. THE STRENGTH OF ASPEN STUDS. Minn. For. Res. Note No. 221, pp. [4]. [1 ref.]

Mellenberger, R. W., Satter, L. D., et al. 1971. DIGESTION OF ASPEN, ALKALI-TREATED ASPEN, AND ASPEN BARK BY GOATS. Repr. from Journal of Animal Science [Fort Collins] 32 (4): 756-63. [14 ref. PR]
A study in the USA showed that both untreated sawdust and bark of P. grandidentata are readily consumed by goats and can provide them with considerable digestible energy. Alkali treatment can increase the digestibility of P. grandidentata by ca. 25%, making it equivalent in energy to low-quality hay.

V[iart?], M. 1965. [ROTARY CUTTING OF THE POPLAR CLONE 'I-214' FOR THE MANUFACTURE OF MATCHBOXES.] Bull. Serv. Cult. Etud. Peuplier et Saule, Paris (1), (37-40). 2 refs. [F.]

84 PRESERVATION AND OTHER TREATMENTS TO IMPROVE THE PROPERTIES OF WOOD. DAMAGING INFLUENCES

844 ATTACK BY PLANT ORGANISMS

Merrill, W., and French, D. W. 1964. WOOD FIBREBOARD STUDIES. 1. A NAILHEAD PULL-THROUGH METHOD TO DETERMINE THE EFFECTS OF FUNGI ON STRENGTH. Tappi 47 (8): 449-51. [4 refs.]

844.2

Merrill, W., Jr. 1964. THE PHYSICAL AND CHEMICAL EFFECTS OF COMMON MOLD FUNGI ON WOOD FIBERBOARD. Abstr. of thesis, in Dissert. Abstr. 25 (4): 2138. O.R.S.
[Cf. F.A. 26 No. 1396.] Boards from groundwood or semichemical pulp of Populus tremuloides and P. grandidentata were exposed to species of 19 genera of Fungi imperfecti, and to soft-rot, white-rot and brown-rot fungi.

Merrill, W., and Cowling, E. B. 1965. EFFECT OF VARIATION IN NITROGEN CONTENT OF WOOD ON RATE OF DECAY. Abstr. in Phytopathology 55 (10): 1067.
In tests on samples cut from different rings of a Populus grandidentata, decay by Polyporus [Polystictus] versicolor and Lenzites trabea was significantly related to N content; threefold differences in N content caused twofold differences in rate of decay.

Merrill, W., and Cowling, E. B. 1966. ROLE OF NITROGEN IN WOOD DETERIORATION [3]. AMOUNTS AND DISTRIBUTION OF NITROGEN IN TREE STEMS. Canad. J. Bot. 44 (11): 1555-80. [27 refs. O.R.S.]

Merrill, W., and Cowling, E. B. 1966. ROLE OF NITROGEN IN WOOD DETERIORATION. IV. RELATIONSHIP OF NATURAL VARIATION IN NITROGEN CONTENT OF WOOD TO ITS SUSCEPTIBILITY TO DECAY. Phytopathology 56 (11): 1324-5. [5 refs.] [Cf. F.A. 27 No. 4971; 28 No. 1466].

Merrill, W., and French, D. W. 1964. DECAY OF WOOD BY ALTERNARIA AND PENICILLIUM. Phytopathology 54 (7): 867-8. 8 refs.

Vehovszky, J. 1969. [NATURAL RESISTANCE TO FUNGI AND PRESERVATION OF POPLAR WOOD.] Faip. Kutatas. (135-42). [Hu.ru.e.g., 12 refs. P.R.]

Tests with 3 white-rot and 3 brown-rot fungi [cf. F.A. 31 No. 3536] on Populus 'Marilandica' and P. 'I-214' indicated that their actual durability was low and differed little between the two hybrids and between their heartwood and sapwood. Both woods (apart from false heartwood) were satisfactorily pressure-treated with such solutions by the Belthell process; uptakes of 70-80% were achieved.

86 PULP INDUSTRIES

861 PULP AND PAPER MANUFACTURE. TEXTILE AND OTHER CELLULOSE DERIVATIVES

Gergely, I. 1973. [COMPARATIVE INVESTIGATION OF DIFFERENT HARDWOOD SEMICHEMICAL PULPS.] Papiripar 17 (1): 1-6. [Hu.ru.de.] From Abstract Bulletin of the Institute of Paper Chemistry 44, 3956. LTP.
Populus 'I-214', P. 'Marilandica', P. 'Robusta', Betula verrucosa, Salix alba and Alnus glutinosa were the best.

Masirevic, D., and Oblak, M. 1966. [POSSIBILITIES OF USING THIN WOOD OF POPULUS 'I-214' IN THE PULP AND PAPER INDUSTRY.] Topola, Beograd 10 (55/56): 2-9. [3 refs. [Serb.e.].]
The unbarked wood gave pulp of satisfactory yield and strength, although bark content was as much as 12·5–14·5% by weight. Neutral sulphite semi-chemical pulp met the requirements for wrapping paper and board, and sulphate pulp could be bleached normally and used for writing and printing papers.

Olszewski, J. 1972. [NEUTRAL SULPHITE SEMI-CHEMICAL PULPS. II. RESEARCH ON THE PREPARATION OF PULPS OF BRITE-CHEM TYPE FROM FAST-GROWING POPLAR SPECIES.] Przeglad Papierniczy 28 (3): 80-84. [Pol., 15 ref.] From Cellulosa e Carta 24 (6): 66. [It.]
Reports favourable results of tests on the suitability of the wood of Populus 'Robusta' and P. 'Hybrid 275' for the preparation of this type of pulp, to be used for the manufacture of white paper.

862 COMPOSITE MATERIALS MADE WHOLLY OR PARTLY OF WOODY MATTER

Anonymous. 1965. THE UNIVERSAL PARTICLEBOARD. Woodwkg. Dig. 67 (5): 31-4. P.R.
An illustrated account of the manufacture of a type of particle board made from Populus grandidentata in northern Wisconsin, and available in a range of 5 densities from 25 to 60 lb./cu. ft.

89 OTHER ("MINOR") FOREST PRODUCTS

Erickson, R. L. 1970. HOT-WATER-SOLUBLE GLYCOSIDES: LOCATION IN THE TISSUE OF POPULUS GRANDIDENTATA BARK. Abstr. of thesis, in Dissert. Abstr. int. 31B (1): 116. [Order No. 70-12, 421, pp. 129. ORS]

Erickson, R. L., Pearl, I. A., and Darling, S. F. 1970. POPULOSIDE AND GRANDIDENCUTOSIDE FROM THE BARK OF POPULUS GRANDIDENTATA. Phytochemistry 9 (4): 857-63. [14 refs. O.R.S.]
Two new glucosides were isolated from the smooth green bark of a Populus grandidentata felled in May. Their structure was established.

Erickson, R. L., Pearl, I. A., and Darling, S. F. 1970. STUDIES ON THE BARKS OF THE FAMILY SALICACEAE. XXIV. FURTHER INVESTIGATIONS OF THE HOT WATER EXTRACTIVES OF POPULUS GRANDIDENTATA MICHX. BARK. Tappi 53 (2): 240-4. [23 refs.]

Pearl, I. A., and Darling, S. F. 1965. BENZOATES OF SALICYLOYL SALICIN FROM THE BARKS AND LEAVES OF POPULUS GRANDIDENTATA AND POPULUS TREMULOIDES. Tappi 48 (9): 506-8. 15 refs.
Represents Paper No. VIII in the series 'Studies on the barks of the family Salicaceae' and No. VI in the series 'Studies on the leaves of the family Salicaceae'.

9 FORESTS AND FORESTRY

FROM THE NATIONAL AND INTERNATIONAL POINTS OF VIEW

Groff, R. W. 1966. MINNESOTA'S ASPEN AND ITS PROJECTED SUPPLY. U.S. For. Serv. Res. Note Nth Cent. For. Exp. Sta. No. NC-4, pp. 4.
A quantitative prediction, at three different cutting levels, of Populus tremuloides and P. grandidentata growing stock likely to be available in the selected years 1970 and 1980

Leuschner, W. A. 1972. PROJECTING THE ASPEN RESOURCE IN THE LAKE STATES [USA]. USDA Forest Service Research Paper, North Central Forest Experiment Station. No. NC-81, 32 pp. [E., 9 ref.]

P. LASIOCARPA TO P. NIGRA AND VARS

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

11 SITE FACTORS: CLIMATE, SITUATION, SOIL, HYDROLOGY

Burg, J. van den. 1972. [MINERAL NUTRITION OF POPULUS 'GELRICA'.] Internal Report nr. 16, Forest Research Station, Wageningen. [Du.]

Burg, J. van den. 1972. [MINERAL NUTRITION OF POPLAR: RESULTS OF THE LEAF ANALYSIS OF DIFFERENT CULTIVARS.] Internal Report nr. 21, Forest Research Station, Wageningen. [Du.]

Burg, J. van den, and Peeters, J. P. 1972. [MINERAL NUTRITION OF POPULUS 'MARILANDICA'.] Internal Report nr. 19, Forest Research Station, Wageningen. [Du.]

Burg, J. van den, and Peters, J. P. 1972. [MINERAL NUTRITION OF POPULUS 'HEIDEMIJ'.] Internal Report nr. 20, Forest Research Station, Wageningen. [Du.]

Harin, N. G. 1965. [THE REFLECTIVE CAPACITY OF SOME PLANTS AND PLANT COMMUNITIES.] Bot. Z. 50 (8): 1115-9 + 12 photos. 4 refs. [Ru.]

Kurir, A. 1963. ZUR BIOLOGIE ZWEIER APHIDOPHAGER SCHWEBFLIEGEN (DIPT. SYRPHIDAE): HERINGIA HERINGI ZETTERSTEDT UND PIPIZA FESTIVA MEIGEN IN DEN GALLEN DER SPATEN BLATTSTIELDREHGALLEN-

PAPPELBLATTLAUS (PEMPHIGUS SPIROTHECAE PASSERINI) AUF DER PYRAMIDENPAPPEL (POPULUS NIGRA VAR. PYRAMIDALIS SPACH). Z. angew. Ent., Hambg. u. Berl. 52 (1): 61-83. [13 Abb., 1 Tab., Lit. Verz., engl. Zsfg.]

16 GENERAL BOTANY

Matuik, I. S. 1971. [SEVERAL BIOLOGICAL FEATURES OF POPULUS NIGRA.] Les. Zh. 3: 137-139. [Ru.]

160 PLANT CHEMISTRY

Charriere-Ladreix, Y. 1973. [DISTRIBUTION OF GLYCOSIDIC FLAVONOIDS IN TISSUES OF THE BUDS OF AESCULUS HIPPOCASTANUM AND POPULUS NIGRA.] Bulletin de la Societe Botanique de France 119 (9): 543-554. [F.e., 13 ref. OBD]

Egger, K., and Tissut, M. 1968. [THE PRESENCE OF [THE FLAVONOIDS] GALANGIN, PINOCEMBRIN AND IZALPININ IN THE BUDS OF POPULUS NIGRA VAR. ITALICA.] C.R. Acad. Sci., Paris 267D (16): 1329-32. [4 refs. [F.f.] O.R.S.]

Egger, K., Tissut, M., and Wollen-Weber, E. 1969. 3-O-METHYL KAEMPFEROL AND 3-O-METHYL GALANGIN FROM THE BUD OIL OF POPULUS NIGRA. Phyto-chemistry 8 (12): 2425-6. [G.e.f., 8 refs. O.R.S.]
These substances, as well as chrysin, galangin, pinocembrin, isalpinin and pinostrobin, were isolated from dormant buds.

Hauteville, M., Chadenson, M., and Chopin, J. 1973. [A NEW TYPE OF NATURAL FLAVONOID: 2,5-DIHYDROXY FLAVONES. I. SYNTHESIS OF 2,6-DIHYDROXY-4-METHOXYDIBENZOYL METHANE EXTRACTED FROM THE BUDS OF POPULUS NIGRA AND EVIDENCE FOR ITS CYCLIC STRUCTURE.] Soc. Chim. France Bull. 5: 1791-1784. Ref. E. sum. [F.]

Hauteville, M., Chadenson, M., and Chopin, J. 1973. [A NEW TYPE OF NATURAL FLAVONOID: 2,5-DIHYDROXYFLAVANONES. II. SYNTHESIS OF SOME 2,6-DIHYDROXYDIBENZOYL-METHANES AND EVIDENCE FOR THEIR CYCLIC STRUCTURE.] Soc. Chim. France Bull. 5: 1784-1788. Ref. Eng. sum. [F.]

Lavie, P. 1973. [ON THE ORIGIN OF PROPOLIS.] Rev. Fr. Apic. 305: 19-21. Ref. [F.]

Roughan, P. G., and Batt, R. D. 1969. THE GLYCEROLIPID COMPOSITION OF LEAVES. Phytochemistry, Oxf. 8 (2): 363-9. [19 refs. O.R.S.]
Tabulates quantitative analyses of the major lipids on photosynthetic tissues of 20 plants including Ginkgo biloba, Pinus radiata, Sorbus aucuparia and Populus nigra var. italica.

Ryzhkov, S. D., and Mokorousova, G. I. 1974. [SOME BIOPHYSICAL AND BIOCHEMICAL INDICES OF SECUAL DIMORPHISM IN DIOECIUS PLANTS.] Soobshch Adad Nau, Gruz SSR 75 (2): 445-448. Eng. sum. [Ru.]

Shimada, M., Yamazaki, T., and Higuchi, T. 1970. METABOLISM OF P-COUMARIC ACID DURING LIGNIFICATION OF BAMBOO. Phytochemistry 9 (1): 1-4. [O.R.S.]

Syzov, S. S., and Syvcev, M. V. 1970. [THE PIGMENT COMPLEX IN LEAVES OF MALE AND FEMALE INDIVIDUALS OF DIOECIOUS PLANTS.] Ukr. bot. Z. 27 (3): 379-82. [Ukr.e., 4 refs. A.P.B.]
Throughout the growing season, but especially in the flowering period, the contents of chlorophyll and carotenoids are higher in the ♀ than in the ♂ plants. The chlorophyll/protein bond is stronger in the ♂s than in the ♀s.

Thieme, H., and Benecke, R. 1969. THE ISOLATION AND COMPOSITION OF A CYCLOLIGNANGLUCOSIDE FROM THE LEAVES OF POPULUS NIGRA. Pharmazie, E. Berlin 24, (567-72). [G., 16 refs., From abstr. in Hort. Abstr. 40 (2), (No. 4587).]

Wollenweber, E., and Egger, K. 1971. [LIPOPHILIC FLAVONOIDS OF POPULUS NIGRA BUD OIL.] Phytochemistry 10 (2): 5-6. [G.e., 4 refs. O.R.S.]

Wollrab, V., Streibl, M., and Sorm, F. 1967. ISO- AND ANTE-ISO-ALKANES IN NATURAL WAXES. Chem. & Ind. (44), (1872-3). [20 refs. 1 gph.]
Includes an analysis of wax from Populus nigra leaves. An iso-alkane structure is suggested for the dominant components (alkanes C_{25}, C_{27}, and C_{29}). Ante-iso-alaknes predominate in the even-numbered homologues.

160.2

Podhorski, I. 1968. ['CAPILLARY PICTURES' OF LEAVES AND BARK OF SOME BLACK POPLAR CLONES.] Topola, Beograd 12 (69/70): 2-9. [Serb.f.] [8 figs.]

160.22

Chadenson, M., Hauteville, M., et al. 1971. [IDENTIFICATION OF A NEW NATURAL PRODUCT, DIHYDROXY-2, 6-METHOXY-4 DIBENZOYL-METHANE, EXTRACTED FROM BUDS OF POPULUS NIGRA.] Comptes Rendus Hebdomadaires des Seances de l'Academie des Sciences, France, D 273 (25): 2658-2660. [F., 11 ref.]

Kamienska, A. 1970. TOCOPHEROLS IN BLACK POPLAR (POPULUS NIGRA). I. CONTENTS IN MALE AND FEMALE INFLORESCENCES. Zesz. Nauk. Uniw. Toruniu, Nauki Mat. -Przyr. -Biol. No. 13, (81-3). [E., Title from Abstr. Bull. Inst. Paper Chem. 42 (2): 1778. LTP.]

Streibl, M., and Konecny, K. 1967. SEPARATION OF HIGHER 2-METHYL AND 3-METHYLALKANES BY CAPILLARY COLUMN CHROMATOGRAPHY. Chem. & Ind. (13), (546). [12 refs., 1 gph.]
The method was tested inter alia on leaf wax of Populus nigra. Results, confirmed by mass spectrometry, indicated that the alkane homologues C_{25}, C_{27}, and C_{29} predominated and that only 2-methylalkanes were present.

161 PHYSIOLOGY

Brand, R., and Venverloo, C. J. 1973. THE FORMATION OF ADVENTITIOUS ORGANS. II. THE ORIGIN OF BUDS FORMED ON YOUNG ADVENTITIOUS ROOTS OF POPULUS NIGRA L. 'ITALICA'. Acta Botanica Neerlandica 22 (4): 399-406. [E., 10 ref. OBD]
Young adventitious roots formed by tissue cultures or stem cuttings produced buds when treated with kinetin or 6-benzylaminopurine (BA).

Davtyan, V. A. 1970. [DIFFERENCES IN THE FUNCTIONAL ACTIVITY OF THE LEAVES AND ROOTS IN STAGHEADED AND NORMALLY GROWING POPLAR.] In Ontogenez vyssh. rast. Erevan. pp. 280-7. [Ru., From abstr. in Referat. Zh. 1971 (4.56.100). Ru. NLL]

Heine, R. W. 1970. ESTIMATION OF CONDUCTIVITY AND CONDUCTING AREA OF POPLAR STEMS USING A RADIOACTIVE TRACER. Ann. Bot. 34 (138): 1019-24. [13 ref. OBD]

Heine, R. W., and Farr, D. J. 1973. COMPARISON OF HEAT PULSE AND RADIOISOTOPE TRACER METHODS FOR DETERMINING SAPFLOW VELOCITY IN STEM SEGMENTS OF POPLAR. Journal of Experimental Botany 24 (81): 649-654. [E., 17 ref. OBD]

Kamienska, A. 1971. [AUXIN CONTENT IN DEVELOPING LEAVES OF BLACK POPLAR TREES.] Rocz. Nauk. Roln. Ser. A. Rosl. 97 (2): 113-126. Ref.

Kamienska, A. 1972. ENDOGENOUS AUXINS AND GROWTH INHIBITORS IN THE DEVELOPING INFLORESCENCES AND INFRUCTESCENCES OF BLACK POPLAR (POPULUS NIGRA L.). Acta Societatis Botanicorum Poloniae 41 (3): 393-400. [E.pl., 23 ref., OBD]

Leike, H. 1967. [EFFECT OF GIBBERELLIC ACID AND KINETIN ON RESTING BUDS OF VARIOUS WOODY SPECIES.] Flora, Jena 158A (3): 351-62. [29 refs. [G.g.e.] O.B.D.]

Mgaloblishvili, M. P., and Sanadze, G. A. 1973. [THE HILL REACTION IN ISOLATED CHLOROPLASTS OF POPLAR.] Soobshch. Akad. Nauk. Gruz. SSR 69 (2): 421-424. [Ru.e.]

Pieters, G. A. 1972. [A NEW METHOD FOR CONTROLLING LEAF TEMPERATURES IN ASSIMILATION CHAMBERS USED FOR THE MEASUREMENT OF GAS EXCHANGE PHENOMENA.] Wageningen Landbouwhogesch. Mededel 72-32, 14 p. Ref.

Rajda, V. 1972. [SEASONAL VARIABILITY OF THE NATURAL ELECTRIC CURRENT OF PLANTS.] Drevarsky Vyskum 17 (4): 197-214. [Cs.ru.de.e., 22 ref., PR]
'Geo-phyto' electric potentials and currents were found to be present all the year round, but the correlation of seasonal variations in their values with environmental factors and physiological mechanisms was complex and did not display the usual direct physical dependence.

Sanadze, G. A. 1966. [THE MECHANISM OF PRODUCTION OF THE DIENE C_5H_8 (ISOPRENE) IN ILLUMINATED LEAVES.] Fiziol. Rast. 13 (5): 753-61. [24 refs. [Ru.ru.e.] A.P.B.]
Results suggest that decarboxylation processes are important for the synthesis of C_5H_8, and that the pentose cycle is also involved in this synthesis.

Sanadze, G. A. 1966. [RELATIONSHIP BETWEEN THE EVOLUTION OF C_5H_8 BY LEAVES AND THE OXYGEN PRESSURE IN THE ATMOSPHERE.] Dokl. Akad. Nauk SSSR 167 (3): 714-6. [5 refs. [Ru.] O.R.S.]
Results showed that C_5H_8 evolution is not promoted, but rather hindered, by the processes of photooxidation.

Sanadze, G. A., and Dzhaiani, G. I. 1972. [DISTRIBUTION OF CARBON ASSIMILATED DURING PHOTOSYNTHESIS IN ISOPRENE MOLECULES.] Soviet Plant Physiol. 19 (5): 924-930.

Sanadze, G. A., and Kalandadze, A. N. 1966. [EVOLUTION OF THE DIENE C_5H_8 BY LEAVES OF POPLAR UNDER DIFFERENT LIGHT CONDITIONS.] Dokl. Akad. Nauk SSSR 168 (1): 227-9. [6 refs. [Ru.] O.R.S.
Red rays of the spectrum were the most effective for evolution of C_5H_8. The curves of photosynthesis and C_5H_8 evolution were in general agreement.

Sanadze, G. A., and Kalandadze, A. N. 1966. [LIGHT AND TEMPERATURE CURVES OF THE EVOLUTION OF C_5H_8.] Fiziol. Rast. 13 (3): 458-61. [6 refs. [Ru.ru.e.] A.P.B.]
It was found that light saturation of C_5H_8 evolution and of photosynthesis occur at about the same light intensity (10×10^3 luxes). C_5H_8 evolution increases with increasing temperature up to a maximum at 38-40° C., and then decreases sharply to zero at temperatures > 43°.

Sanadze, G. A., and Kursanov, A. L. 1966. [CERTAIN CONDITIONS FOR EVOLUTION OF THE DIENE C_5H_8 FROM POPLAR LEAVES.] Fiziol. Rast. 13 (2): 201-7. 16 refs. [Ru.ru.e.] A.P.B.
Measurements (with C^{11} as a tracer) on detached leaves of Populus nigra showed that evolution of C_5H_8 is a stable process which may proceed at a constant rate for many hours. It takes place actively only in light and when CO_2 is deficient, though small amounts of the latter must be present. Evolution of C_5H_8 was sharply depressed when the leaves were supplied with nitrate.

Sauter, J. J. 1967. [THE INFLUENCE OF DIFFERENT TEMPERATURES ON STARCH RESERVES IN PARENCHYMA TISSUE OF TREE STEMS.] Z. PflPhysiol., Stuttgart 56 (4): 340-52. [20 refs. [G.g.e.] O.B.D.]

Vasil'ev, A. E. 1970. [LOCALIZATION OF THE SYNTHESIS OF TERPENOIDS IN THE PLANT CELL. ELECTRON-MICROSCOPE DATA.] Rast. Resursy 6 (1): 29-45 + 8 plates. [Ru., 60 refs., N.L.L.]

Venverloo, C. J. 1973. THE FORMATION OF ADVENTITIOUS ORGANS. I. CYTOKININ INDUCED FORMATION OF LEAVES AND SHOOTS IN CALLUS CULTURES OF POPULUS NIGRA L. 'ITALICA'. Acta Botanica Neerlandica 22 (4): 390-398. [E., 18 ref., OBD]
Zeatin was the most successful of four cytokinins used to stimulate organ formation in 1- to 4-year-old callus cultures, and induced shoot formation at concentrations as low as 10^{-8} M.

161.4

Ghugale, D. D., Kulkarni, D. D., et al. 1971. EFFECT OF AUXINS AND GIBBERELLIC ACID ON GROWTH AND DIFFERENTIATION OF MORUS ALBA AND POPULUS NIGRA TISSUES IN VITRO. Indian Journal of Experimental Biology 9 (3): 381-384. [E., 18 ref.]

Hoffmann, G., and Lyr, H. 1974. [GROWTH SCHEME TO DEMONSTRATE THE YEARLY SIZE OF VARIOUS INCREMENTS IN GROVES.] In International Symposium Ecology and Physiology of Root Growth 2d: 275-282. [G.]

163 EMBRYOLOGY

Barna, M. M. 1969. [EMBRYOLOGICAL INVESTIGATIONS ON POPULUS NIGRA VAR. ITALICA.] Ukr. bot. Z., 26 (1): 93-100. [18 refs. [Ukr.ru.e.] A.P.B.]
Gives results of investigations on micro- and macrosporogenesis, development of the ♀ gametophyte, fertilization, and the development of embryo and endosperm.

164 MORPHOLOGY

Anonymous. 1969. [THE FLORAL ORGANS OF POPULUS LASIOCARPA.] Bull. Serv. Cult. Etud. Peuplier et Saule (23-31). [F., 5 refs.]

Giurgiu, R. 1972. [A SIMPLIFIED PROCEDURE FOR DETERMINING THE AREA OF THE LEAVES OF [BROADLEAVED] FOREST SPECIES.] Revista Padurilor 87 (9): 416-420 + smries. [Ro.f.ru.e.de.]

164.3

Nanda, K. K., et al. 1979. [EFFECT OF SOURCES, AUXINES & GIBBERELLIC ACID ON ROOTING OF STEM SEGMENTS & POPLARS NIGRA UNDER VARYING LIGHT CONDITIONS.] Pl Cell Physiol. Tokyo, 9 (4): 735-43.

Nanda, K. K., Bhattacharya, N. C., and Kochlar, V. K. 1974 BIOCHEMICAL BASIS OF ADVENTITIOUS ROOT FORMATION ON ETIOLATED STEM SEGMENTS. N.Z. J. For. Sci. 4 (2) 347-358. Ref.

Tucovic, A. 1973. [STUDY OF THE MORPHOLOGY OF THE ROOT SYSTEM OF BLACK POPLAR.] Glasnik Sumarskog Fakulteta, Univerzitet u Beogradu No. 44, 117-129. [Sh.e., 9 ref.]
Gives data on the depth and distribution of the root system o plants 1-4 years old in nursery-type conditions, and also of plants i natural stands in Serbia. On lowland sites the root system is fairly superficial but some of the roots do penetrate deeply; on upland sites the root system is entirely superficial.

165 PHYLOGENY, EVOLUTION. HEREDITY, GENETICS AND BREEDING, VARIATION

Hyun, S. K. 1974. [THE EXPRESSION OF HETEROSIS OF IMPROVED HYBRID POPLARS (POPULUS EURAMERICANA) IN KOREA BEING INFLUENCED BY THE SITE AND THE CULTURAL METHOD.] J. Natl. Acad. Sci. Repub. Korea Nat. Sci Ser. 13: 231-251. Map. Ref.

Knorzer, K. H. 1971. [MEDIEVAL OCCURRENCE OF BLACK POPLAR IN THE LOWER RHINE.] Decheniana 123 (1/2): 249-252. [G.]

165.3/.7

Chiba, S., and Nagata, Y. 1972. RUST RESISTANCE AND GROWTH OF POPULUS MAXIMOWIEZII CLONES SELECTED FROM THE PROGENIES OF INTRASPECIFIC HYBRIDIZATION. In Proceedings of the Joint Symposia for Forest Tree Breeding of Genetics Subject Group, IUFRO, and Section 5, Forest Trees, SABRAO. Tokyo, Japan, Government Forest Experiment Station of Japan. C-6(V): 1-7. [E., 4 ref.]

Chiba, S., and Nagata, Y. 1973. [STUDIES ON THE BREEDING OF POPULUS SPECIES. 3. RUST RESISTANCE AND GROWTH OF POPULUS MAXIMOWICZII CLONES SELECTED FROM THE PROGENIES OF INTRASPECIFIC HYBRIDIZATION.] Technical Note, Oji Institute for Forest Tree Improvement No. 124, 4 pp. [Jap.e., 4 ref.]

Jovanovic, B., and Tucovic, A. 1964. [THE FIRST, INBRED GENERATION OF A MONOECIOUS POPULUS NIGRA TREE IN THE KOSOVSKA MITROVICA DISTRICT.] Topola, Beograd 8 (42/43): 13-9. 6 refs. [Serb.f.]

Petrov, M. 1966. [INHERITANCE OF CERTAIN FEATURES BY THE HYBRID PROGENY OF POPULUS NIGRA CV. 'SCHIPKA' X P. NIGRA CV. ITALICA 'S'.] Gorskostop. Nauka, Sofija 3 (1): 19-32. [6 refs. [Bulg.ru.e.] N.L.L.]

Petrov, S. A., and Skupchenko, V. B. 1971. [MORPHOLOGICAL FEATURES AND HISTO-ANATOMICAL STRUCTURE OF SHOOTS OF THE CHIMAERA POPULUS 'KAZAKHSTANSKII -272' AND OF THE COMPONENTS OF THE GRAFT.] Lesn. Zh. 14 (2): 136-9. [Ru., 8 ref.]
In most anatomical features the chimaera is closer to the rootstock (P. nigra var. italica), but in some others, e.g. the presence of sclereids in the bark, it is distinct from both stock and scion components.

Siwecki, R., and Giertych, M. 1965. [THE EVALUATION OF GENETIC PARAMETERS FOR ROOTING ABILITY OF CUTTINGS AND ONE-YEAR HEIGHT OF POPLAR HYBRIDS.] Repr. from Acta Soc. Bot. Polon. 34 (3): 533-48. 9 refs. [Pol.pol.e.]

Sung, C. S., Fang, C., and Teng, M. C. 1964. [A PRELIMINARY STUDY ON THE [GENERAL] MORPHOLOGY AND ROOT SYSTEM OF LOMBARDY POPLAR.] Sci. Silvae, Peking 9 (3) 256-63. 8 refs. [Chin.] N.L.L.
Includes diagrams of root systems, photos of habit and bark, and a tabular comparison of these and other characters of the ♂ and ♀ forms of Populus nigra var. italica.

Zufa, L. 1969. THE HERITABILITY OF THE STEM FORM OF BLACK POPLAR (POPULUS NIGRA L.). [Pap.] 2nd FAO/IUFRO World Consult. For. Tree Breed., Washington 1969 No. FO-FTB-69-3/7, pp. 12. [3 refs. [E.e.].]
Results indicated that there is a high degree of heritability of stem form, and that straightness is dominant.

168 HISTOLOGY

Narasimhan, R., Dhruva, B., et al. 1970. TISSUE CULTURE OF SOME WOODY SPECIES. Proc. Indian Acad. Sci. 71B (5): 204-12. [23 refs. O.R.S.]
Describes different methods of growing tissue cultures of Tectona grandis, Artocarpus heterophyllus, Morus alba and Populus nigra.

17 SYSTEMATIC BOTANY

176.1 DICOTYLEDONEAE

Amels, C. W. 1974. [BLACK POPLAR – THE CONSERVATION OF AN INDIGENOUS SPECIES [IN THE NETHERLANDS].] Nederlands Bosbouw Tijdschrift 46 (10): 200-211. [Nl.e., 25 ref.]

Broekhuizen, J. T. M. van, Visser, G. R., and Tenge, O. R. 1971. [DESCRIPTION AND IDENTIFICATION OF THREE CLONES OF POPULUS NIGRA.] Ned. Bosb. Tijdschr. 43 (2): 51-4. [Du., 4 refs.]

Bugala, W. 1969. [POPULUS NIGRA CV. 'ITALICA' AND P USBEKISTANICA CV. 'AFGHANICA'.] Roczn. Dendrol. Polsk Tow. Bot., Warsz. 23, (39-62). [67 refs. [Pol.e.].]

Petrov, M. 1965. [FEATURES OF THE LEAF SHAPE OF CULTIVARS OF THE HYBRID COMBINATION POPULUS X MARILANDICA X P. NIGRA VAR. ITALICA.] Gorskostop Nauka, Sofija 2 (2): 87-99. [5 refs. [Bulg.ru.f.].]

Petrov, M. 1965. [MORPHOLOGICAL AND GROWTH FEATURES OF SOME PYRAMIDAL POPLARS CULTIVATED IN BULGARIA.] Gorskostop. Nauka, Sofija 2 (5): 353-61. [14 refs. [Bulg.ru.e.].]
The differences found confirm that the five should be regarded as separate cultivars (italica, italica 'S', 'Schipka', thevestina 'P', and 'Plevenska').

Stace, C. A. 1971. THE MANCHESTER POPLAR. Watsonia 8 (4): 391-3. [9 ref.]
A brief note on Populus nigra var. betulifolia, its distribution in England, and especially its continued existence in parts of Manchester as a park and roadside tree, suggesting that it is still worth planting for such purposes.

Zarhina, E. S. 1966. [POPULUS SUAVEOLENS IN THE UPPER AMUR BASIN.] Bot. Z. 51 (3): 411-6. 26 refs. [Ru.]

18 PLANT ECOLOGY

181 MODE OF LIFE, AUTECOLOGY. SILVICULTURAL CHARACTERS OF TREES

181.1

Duhme, H. 1966. [THE OCCURRENCE OF POPULUS NIGRA IN LOWER SAXONY.] Forst- u. Holzw. 21 (9): 211-2. [G.]

Papaioannou, J. 1964. THE GEOGRAPHICAL DISTRIBUTION OF POPULUS NIGRA L. VAR. PUBESCENS PARLAT. AND OF POPULUS THEVESTINA DODE AND THEIR HYBRIDS. In Proc. FAO World Consult. For. Genet., Stockholm 1963 No. 4/11, pp. iii + 15. 27 refs. [E.e.f.span.]
In the Balkans and Asia Minor.

181.2

Jovanovic, S. 1970 [SIGNIFICANCE OF APPEARANCE OF PHOTOPERIODISM TO ANNUAL COURSE OF HEIGHT GROWTH AT SOME CULTIVARS OF EUROAMERICAN POPLARS (POPULUS X EUROAMERICANA (DODE) GUINIER) UNDER CONDITIONS OF SERBIA.] Inst. Sumar. Drvnu. Ind. Zb. 9: 239-251. [Cro.e.]

Sakai, A. 1965. DETERMINING THE DEGREE OF FROST-HARDINESS IN HIGHLY HARDY PLANTS. Nature, Lond. 206 (4988): 1064-5. 6 refs.
The effective pre-freezing temperature for Populus maximowiezii was −15° C., for P. nigra it was below −20°. In every experiment it was found that the greater the frost-hardiness, the higher the effective pre-freezing temperature.

181.3

Adorjan, J. 1966. [THE SUITABILITY OF ALDER SITES ON SOMOGY STAND FOR THE GROWING OF BLACK POPLAR HYBRIDS.] Erdesz. Kutatas., Budapest 62 (1/3), (89-111). [5 refs. [Hu.ru.g.].]
Gley soils with high nutrient content and favourable water regime are considered highly suitable for Poplar growth, especially where soil depth to groundwater in May is ≮ 0·5 m. or can be made so by mound planting. On such sites, Poplars are expected to yield as much in 20 years as Alders in 60.

181.31

Braun, H. J. 1974. [GROWTH RESPONSES OF POPLARS UNDER CONDITIONS OF OPTIMUM AND REDUCED WATER SUPPLY.] Allgemeine Forst- und Jagdzeitung. 145 (6): 112-113. [De.e.f., 7 ref.]

Hoffmann, G., and Lyr, H. 1973. [CHARACTERIZATION OF THE MODE OF GROWTH OF PLANTS BY GROWTH PATTERNS.] Flora, German Democratic Republic 162 (1/2): 81-98. [De.e., 50 ref., OBD].

181.32/.34

Keller, T. 1968. THE INFLUENCE OF MINERAL NUTRITION ON GASEOUS EXCHANGE BY FOREST TREES. Phosphorus in Agriculture, London 22 (50): 21-31. [8 refs. [E.] A.P.B.]
Discusses laboratory experiments on hybrid Black Poplars with Fe and on Populus nigra with N and P.

181.34

Vukorep, I. 1969. BEZIEHUNGEN ZWISCHEN CHEMISCHEN BODENEIGENSCHAFTEN UND DEM ZUWACHS VON SCHWARZPAPPELN. Diss. Forstl. Fak. Gorg-August-Univ. Gottingen in Hann. Munden, III + 104 S. [6 Abb., 25 Tab., 56 Lit. Ang.]

181.35

Golubinskaia, N. S. 1973. [ON THE EFFECT OF GROWTH SUBSTANCES ON VIABILITY, GROWTH AND ENDOTROPHIC

MYCROPHIZA OF POPULUS LAURIFOLIA.] In Mikroflora Rastenii i Pochv p. 99-105. Ref. [Ru.]

Zerova, M. Ja. 1966. [INOCYBE BOLTONI VAR. IONIPES, A MYCORRHIZAL SYMBIONT OF QUERCUS ROBUR AND POPULUS NIGRA.] Ukr. bot. Z. 23 (5): 62-6. [6 refs. [Ukr.ru.e.] A.P.B.]
Describes the discovery of the fungus on both species in the field, and some inoculation experiments with potted Oak seedlings, which formed mycorrhizae much more readily with inocula derived from Oak than with those from Poplar.

181.36

Nanda, K. K., Purohit, A. N., and Mehrotra, K. 1968. EFFECT OF SUCROSE, AUXINS AND GIBBERELLIC ACID ON ROOTING OF STEM SEGMENTS OF POPULUS NIGRA UNDER VARYING LIGHT CONDITIONS. Plant Cell Physiol. 9 (4): 735-743.

181.5

Al'bickaja, M. A. 1966. [THE SPECIES AND NUMBERS OF VIABLE SEEDS IN THE SOIL OF PLANTATIONS IN THE MIDDLE DNIEPER REGION.] Bjull. Mosk. Obsc. Ispyt. Prir. (Otd. Biol.) 71 (4): 60-70. [17 refs. [Ru.ru.e.] N.L.L.]
Fewest seeds were found on the local elevations in relief, whence they are blown to the depressions. In all stands, the greatest number of viable seeds occurred in the top layer of soil (0-5 cm.).

Cheng, K. H., et al. 1964. [THE LOSS IN DEHYDROGENASE ACTIVITY IN POPLAR SEEDS DURING STORAGE, AND REACTIVATION WITH PYRIDINE NUCLEOTIDES.] Acta bot. sinica 12 (4): 325-32. 39 refs. [Chin.e.] C.G.B.
Studies on Populus nigra var. italica seeds showed that, in general, their respiration rate, dry weight, content of available sugar, activity of some respiratory enzymes, and dehydrogenase activity (d.a.) all decreased as seed viability declined during storage.

Chira, E., and Bielikova, K. 1972. [REMOVAL OF POLLEN STERILITY AND INVESTIGATIONS INTO POLLEN DEVELOPMENT WITH MORE THAN N CHROMOSOMES IN POPULUS EUROAMERICANA (DODE) GUINIER VAR. "ROBUSTA".] Lesnictvi 18 (6): 551-565. Ref. [Slo.e.]

Matyuk, I. S. 1971. [SOME BIOLOGICAL FEATURES OF POPULUS NIGRA.] Lesn. Zh. 14 (3): 137-9. [Ru.]
A note describing the ability of exposed roots to sucker.

Melchior, G. H. 1967. [THE OCCURRENCE OF TWO HERMAPHRODITE POPLARS OF THE SECTION AIGEIROS.] Silvae Genet. 16 (2): 77-80. [19 refs. [G.g.e.].]

181.71

Bojarczuk, T. 1970. [ANCIENT BLACK POPLARS (POPULUS NIGRA) IN THE KORNIK ARBORETUM.] Roczn. Dendrol. Polsk. Tow. Bot. 24, (87-90). [Pol.e., 7 refs.]
A note on the remnants of an avenue planted in 1792 in this Polish arboretum.

181.8

Gowin, T. 1965. [INVESTIGATIONS ON THE PERIOD OF DORMANCY IN POPULUS NIGRA VAR. ITALICA.] Zesz. nauk. Szkol. Gospod. Wiejsk. Warsz. (Lesn.) No. 7, (39-54). [16 refs. [Pol.e.ru.].]
The depth and duration of summer and winter dormancy of shoots were investigated with the aid of defoliation, warm-water baths, continuous light, and cold treatment.

Tucovic, A. 1971. [THE MAIN PHENOLOGICAL PHASES OF POPULUS NIGRA AND THEIR IMPORTANCE IN FOREST TREE BREEDING.] Glasnik Sumarskog Fakulteta, Univerzitet u Beogradu, A No. 38, 121-131. [Sh.e., 20 ref., NLL]
Gives results of observations on the phenology of 112 trees of P. nigra in 1958-62 near Belgrade and Kosovska Mitrovica, Serbia.

182 SYNECOLOGY, PLANT SOCIOLOGY

182.2

Alekhina, A. F. 1970. [BLACK POPLAR STANDS OF BOTTOM LAND OF THE OB RIVER.] Akad. Nauk. SSSR Izv. Sib. Otd. Ser. Biol. Nauk 10 (2): 53-59. map. [Ru.]

Yoshioka, K. 1966. DEVELOPMENT AND RECOVERY OF VEGETATION SINCE THE 1929 ERUPTION OF MT. KOMAGATAKE, HOKKAIDO. I. AKAIKAWA PUMICE FLOW. Ecol. Rev., Sendai 16 (4): 271-92. [4 refs. [E.e.] O.B.D.]

187 VEGETATION TYPES

Doing, H. 1969. [THE VEGETATION OF POPLAR WOODLAND IN THE NETHERLANDS.] Populier, Wageningen 6 (2): 22-5. [3 refs. [Du.] 2 figs.]
Briefly describes 8 forest types in the Netherlands and the ground vegetation of the two (Alder/Ash and Willow/Poplar) where Black Poplar occurs naturally, and discusses the possibility of establishing Poplars on the other 6 types.

Pavlov, V. N. 1966. [FEATURES OF THE FORESTS OF THE PSKEM FLOODPLAIN [TIEN-SHAN MOUNTAINS].] Bot. Z. 51 (2): 265-9. 17 refs. [Ru.]

2 SILVICULTURE

22 SILVICULTURAL SYSTEMS. CONSTITUTION AND COMPOSITION OF STANDS; FORMS OF STAND

Rubanov, B. V. 1971. [CHARACTERISTICS OF THE CULTIVATION OF OAK AND BLACK POPLAR IN THE VOLGA-AKHTUBA FLOOD PLAIN AND VOLGA DELTA.] Les. Khoz. 12: 40-41. [Ru.]

23 REGENERATION AND FORMATION OF STANDS

232 ARTIFICIAL REGENERATION

232.12

Avanzo, E. 1967. [A PRELIMINARY ACCOUNT OF A YOUNG POPULUS NIGRA L. TRIAL NEAR ROME.] Proc. 14th Congr. Int. Union For. Res. Organ., Munich 1967 Pt. VI, Sect. 25, (255-61). [F.]
Compares growth at age 4 of 8 clones (including 5 with fastigiate form).

232.13

Bowersox, T. W., and Ward, W. W. 1968. JUVENILE GROWTH AND YIELD OF HYBRID POPLAR CLONE NE-388. Res. Briefs Sch. For. Resour. Pa. St. Univ. 3 (1): 2-6.
The average annual yield of wood fibre of the most closely spaced plantation after two growing seasons compared favourably with that of a natural stand of Populus grandidentata on a similar site, and was greater than that of the wider spacings, though the trees were smaller.

Petrov, M. 1966. [MORPHOLOGY AND GROWTH OF POPULUS X EURAMERICANA CV. 'BG-4',] Gorskostop. Nauka, Sofija 3 (6): 443-50. [6 refs. [Bulg.ru.f.].]
On leached chernozem P. 'Bg-4' shows the better early growth, but on meadow-swamp soil P. 'I-214' is superior.

232.3

Banadics, I. 1973. [PRODUCTION OF POPULUS X EURAMERICANA PROPAGATING MATERIAL IN CENTRAL HUNGARY.] Erdo 22 (4): 187-188. [Hu.]

232.315

Mattis, G. Ja. 1966. [STORAGE OF ACORNS AND SEEDLINGS IN PLASTIC BAGS.] Lesn. Hoz. 19 (10): 78-81. [Ru.]
An account of promising results in storing acorns and Birch, Scots Pine and Populus nigra seedlings in polythene bags.

232.324

Dadykin, V. P., and Samsonova, L. P. 1974. [POSSIBLE WAYS OF PROLONGING THE PLANTING PERIOD IN SPRING WITH THE AID OF ANTI-TRANSPIRANTS.] Lesnoi Zhurnal 17 (3): 18-22. [Ru., 12 ref.]

232.328

Anonymous. 1974. SPECIAL ISSUE ON VEGETATIVE PROPAGATION. PART 4. PHYSIOLOGY AND BIOCHEMISTRY OF VEGETATIVE PROPAGATION. New Zealand Journal of Forestry Science 4 (2): 291-358. [E., many ref.]

Burgos, J. C., and Mavrich, E. 1965. [GROWTH OF POPULUS NIGRA VAR. THAYSIANA IN THE NURSERY AT THE END OF THE FIRST GROWING SEASON.] Rev. for. argent. 9 (1): 3-6. [Span.]

Michniewicz, M., and Kriesel, K. 1970. DYNAMICS OF AUXINS, GIBBERELLIN-LIKE SUBSTANCES AND GROWTH INHIBITORS IN THE ROOTING PROCESS OF BLACK POPLAR CUTTINGS (POPULUS NIGRA L.). Acta Soc. Bot. Polon. 39 (2): 383-90. [E.pol., 27 refs. O.B.D.]
Amounts of growth substances increased at first, reached a maximum after root emergence, and then decreased. Gibberellin-like substances appeared only after roots had emerged, and their quantity increased during root growth. Growth inhibitors were present in great quantity in freshly cut shoots, but amounts decreased markedly during root formation and growth.

Nanda, K. K., and Anand, V. K. 1970. SEASONAL CHANGES IN AUXIN EFFECTS ON ROOTING OF STEM CUTTINGS OF POPULUS NIGRA AND ITS RELATIONSHIP WITH MOBILIZATION OF STARCH. Physiol. Plant., Copenhagen 23 (1): 99-107. [21 refs.]

Nanda, K. K., and Bhattacharya, N. C. 1973. ELECTROPHORETIC SEPARATION OF RIBONUCLEIC ACIDS ON POLYACRYLAMIDE GELS IN RELATION TO ROOTING OF ETIOLATED STEM SEGMENTS OF POPULUS NIGRA. Biochemie und Physiologie der Pflanzen 164 (5/6): 632-635. [E., 12 ref. OBD]
The production of two new RNA molecules of low molecular weight was induced by IAA during the initiation and development of roots in etiolated stem segments of P. nigra. The synthesis of these molecules was suppressed by actinomycin-D, and it is suggested that the molecules are concerned with the production of adventitious roots.

Nanda, K. K., Bhattacharya, N. C., and Kaur, N. P. 1973. DISC ELECTROPHORETIC STUDIES OF IAA OXIDASES AND THEIR RELATIONSHIP WITH ROOTING OF ETIOLATED STEM SEGMENTS OF POPULUS NIGRA. Physiologia Plantarum 29 (3): 442-444. [E., 18 ref.]

Nanda, K. K., and Jain, M. K. 1972. UTILIZATION OF SUGARS AND STARCH AS CARBON SOURCES IN THE ROOTING OF ETIOLATED STEM SEGMENTS OF POPULUS NIGRA. New Phytologist 71 (5): 825-828. [E., 12 ref. OBD]
Stem segments 2.5 cm. long of P. nigra did not root in water or auxin alone, but did root in 0.5% solutions of ribose, glucose and sucrose. The addition of 0.1 mg/litre IAA or IBA to the medium stimulated rooting, IBA being more effective. Starch also induced rooting, and was hydrolysed by enzymes that leached out of the segments; the presence of auxins enhanced the activity of the hydrolytic enzymes.

Nanda, K. K., Jain, M. K., and Bhattacharya, N. C. 1973. ROOTING RESPONSE OF ETIOLATED STEM SEGMENTS OF POPULUS NIGRA TO ANTIMETABOLITES IN RELATION TO INDOLE-3-ACETIC ACID AND GLUCOSE. Biologia Plantarum 15 (6): 412-418. [E.es., 17 ref., ORS]

Nanda, K. K., Jain, M. K., and Malhoira, S. 1971. EFFECT OF GLUCOSE AND AUXINS IN ROOTING ETIOLATED STEM SEGMENTS OF POPULUS NIGRA. Physiol. Plant. 24 (3): 387-91. [7 ref.]
Stem segments 2-5 cm. long of Populus nigra did not root when cultured in water or in auxin solutions alone but rooted when glucose was present. Auxin effects on rooting seem to be influenced by the nutrient status of the cuttings, and a proper balance is probably necessary for root development.

Nanda, K. K., Purohit, A. N., and Kochhar, V. K. 1969. EFFECT OF AUXINS AND LIGHT ON ROOTING STEM CUTTINGS OF POPULUS NIGRA, SALIX TETRASPERMA, IPOMEA FISTULOSA AND HIBISCUS NOTODUS IN RELATION TO POLARITY. Physiol. Plant., Copenhagen 22 (6): 1113-20. [18 refs.]

232.411

Koster, R. 1970. [EEC QUALITY STANDARDS FOR TRADE IN POPLARS OF SECTION AIGEIROS.] Populier 7 (4): 61-3. [Du.]

Nicolae, C., Oprica, A., and Clonaru, A. 1970. [INFLUENCE OF SEEDLING SIZE AND SOIL PREPARATION UPON POPULUS EURAMERICANA DEVELOPMENT.] Rev. Padurilor 85 (5): 257-260. [Ru.]

232.43

Sakamoto, T. 1969 [TEN-YEAR GROWTH AT DIFFERENT SPACING OF LARIX LEPTOLEPIS AND OTHER 7 SPECIES.] Tech. Note Oji Inst. For. Tree Impr. No. 77, pp. 24 + smry. [Jap.e., 3 ref.]

Stawecka, W. 1971. [EFFECT OF SPACING ON THE INCREMENT OF POPULUS 'MARILANDICA' IN A PLANTATION IN THE VISTULA VALLEY.] Prace Inst. Bad. Lesn. No. 398/400, (29-53). [Pol.ru.de., 24 ref.]

233 AFFORESTATION

Czapowskyj, M. M. 1970. EXPERIMENTAL PLANTING OF 14 TREE SPECIES ON PENNSYLVANIA'S ANTHRACITE STRIP-MINE SPOILS. U.S. For. Serv. Res. Pap. Ntheast. For. Exp. Sta. No. NE-155, pp. 18. [6 refs.]

Czapowskyj, M. M., and Sowa, E. A. 1973. LIME RETENTION IN ANTHRACITE COAL-BREAKER REFUSE. USDA Forest Service Research Note, Northeastern Forest Experiment Station No. NE-154, 4 pp. [E., 2 ref.]
In 1965 hydrated lime was applied at rates of 2.5 and 5.0 tons/acre to extremely acid spoil mounds in Pennsylvania, before planting. Hybrid Poplar (clone NE-388) had 80% survival and had grown 3.9 ft after three growing seasons. No trees survived on unlimed plots.

LaBarre, C., and Veilleux, J.-M. 1973. [SILVICULTURAL TREATMENTS IN PLANTATIONS ESTABLISHED ON DUNES AT SAINT-CLET AND SAINT-LAZARE, VAUDREUIL-SOULANGES COUNTY [QUEBEC].] Memoire, Service de la Recherche, Direction Generale des Forets, Ministere des Terres et Forets, Quebec No. 15, xiii + 42 pp. [F.e., 20 ref.]

236 CARE OF REGENERATION OR PLANTATIONS IN THE INITIAL STAGES OF ESTABLISHMENT

Detz, H. 1965. [WEED CONTROL IN POPLARS.] Extr. from Jaarb. Proefsta. Boomkwek, Boskoop 1964, (110-1). [Du.]

237 AMELIORATION OF FOREST SITES

Leroy, P. 1969. [TREATMENT OF POPLAR WITH FERTILIZERS ON GLEY SOILS IN THE MEUSE VALLEY.] Ann. Sci. for., Paris 26 (3): 301-19. [F.e.g., 13 refs.]
Mowing led to better nutrition and growth, and application of NPK fertilizer in the planting hole improved nutrition, increased the growth rate by 77%, reduced the losses from 38 to 13%, and promoted root growth.

Ozdemir, O. L. 1967. [THE USE OF RADIOACTIVE ISOTOPES IN FORESTRY RESEARCH.] Orm. Arast. Enst. Derg. 13 (1): 3-18. [3 refs. [Turk.].]

After a general survey of the use of radioactive isotopes in forest research, gives a detailed account of their use in a study of fertilizer applications to Populus nigra var. italica.

238 TIMBER PLANTATION CROPS REQUIRING SPECIAL TREATMENT

Grabenstedt, H. 1969. PAPPELANBAU IM WALDE. Holzzucht, Reinbek 23 (2): 17-18. [3 Abb.]

24 TENDING OF STANDS AND TREES

Kohan, S. 1970. [THE TENDING OF POPLAR STANDS.] Lesn. Cas. 16 (3/4): 273-85. [Sk.ru.e.de., 15 ref.]
Presents and discusses further data on thinning intensities and intervals from trials in Populus 'Marilandica' and P. 'Robusta' stands on flood-plain sites in the Danube region and the E. Slovakian plain.

26 COMBINATIONS OF FORESTRY WITH AGRICULTURE

263 IRRIGATED FORESTS

Tircomnicu, C., and Muresan, G. 1969. [ECONOMIC ASPECTS OF THE MECHANIZATION, ESTABLISHING AND MAINTENANCE WORKS OF THE POPULUS EURAMERICANA CULTURES IN THE DAM-BANK ZONE OF THE DANUBE.] Rev. Padurilor 84 (3): 132-134. [Ru.]

Tircomnicu, C., and Muresan, G. 1969. [THE MECHANIZATION TECHNOLOGY INFLUENCES UPON THE POPULUS EURAMERICAN CULTURES OF THE DAM-BANK ZONE OF THE DANUBE.] Rev. Padurilor 84 (2): 81-84. [Ru.]

265 STRIPS OR LINES AT ROAD, RAIL AND CANAL SIDES, ETC.; HEDGEROW TREES

Lange, O. 1964. [POPLARS HELP TO MAKE INDUSTRIAL AREAS GREEN.] Holzzucht, Reinbek 18 (3/4): 24. [G.]

Mozheiko, G. A. 1971. [GROWTH OF TREE SPECIES IN PROTECTIVE STANDS OF THE N. CRIMEAN MAIN CANAL.] Lesn. Khoz. (6), (42-5). [Ru.]

Yang, H. H., et al. 1964. [A METHOD OF ECOLOGICAL STUDY OF POPLARS GROWING AS SCATTERED TREES ON THE LEVEL LAND [PLAINS].] Sci. Silvae, Peking 9 (1): 32-44. 11 refs. [Chin.chin.e.]

Investigations in Populus pyramidalis [P. nigra var. italica] shelterbelts in E. Honan revealed a significant correlation between height growth and water table, and a highly significant correlation between height growth and soil density in the rooting zone.

266 SHELTERBELTS, WINDBREAKS

Cauwenberghe, E. van. 1964. [SHELTER AND WINDBREAKS FOR ORCHARDS.] Fruit Belge, Liege 32 (275): 213-5. [F.] E.M.B.

Chao, T. C. 1965. [CHOICE OF MAIN SPECIES FOR FORMING SHELTERBELTS IN N. CHINA.] Sci. Silvae, Peking 10 (2): 148-59. 10 refs. [Chin.] N.L.L.

Spoiden, G. 1964. [WINDBREAKS IN THE CULTIVATION OF FRUIT TREES.] Fruit Belge, Liege 32 (275): 203-12. 7 refs. [F.] E.M.B.

Sturrock, J. W. 1972. AERODYNAMIC STUDIES OF SHELTERBELTS IN NEW ZEALAND — 2. MEDIUM-HEIGHT TO TALL SHELTERBELTS IN MID CANTERBURY. New Zealand Journal of Science 15 (2): 113-140. [E., 14 ref.]
Presents horizontal wind profiles measured at 0.62 m and 1.25 m above ground for ten shelterbelts containing 1-5 rows (8.5-19.8 m high), and profiles of wind shear, relative free-water evaporation, and air temperature for two of the belts.

27 ARBORETA, ARBORICULTURE FOR ORNAMENTAL PURPOSES

Davidse, G. J. 1971. [PLANTING [LARGE] POPLARS WITHOUT ROOTS.] Ned. Bosb. Tijdschr. 43 (12): 265-7. [Nl.]
Describes and illustrates trials in Holland. Three 15-year-old Populus 'Robusta', averaging 28 cm d.b.h., that had been cut off at the base, transplanted without roots, and watered during dry periods, were indistinguishable from trees from the same row transplanted at the same time with root-balls.

Snyatkov, S. N. 1973. [FULL-SCALE TRIALS ON AMENITY PLANTING ON THE SHORES OF LAKE ISSYK-KUL.] In Kul-tura lesnykh prodd v Kirgizii. Frunze, USSR. Ilim. 44-51. [Ru. 1 ref., NLL]

Tatsumi, S. 1973. [STUDIES ON THE MANAGEMENT TECHNIQUES OF THE STREET TREES. I. THE PRESENT SITUATION OF THE STREET TREE MANAGEMENT IN JAPAN.] Kagawa Daigaku Nogakubu Gakuzyutu Hokoku (Technical Bulletin, Faculty of Agriculture, Kagawa University) 25 (1): 61-69 [Jap.e., EMB]

4 FOREST INJURIES AND PROTECTION

42 INJURIES FROM INORGANIC AGENCIES (EXCLUDING FIRE)

425 CHEMICAL INFLUENCES (ATMOSPHERIC)

Bolay, A., and Bovay, E. 1965. [THE SENSITIVITY TO FLUORINATED GASES OF SOME PLANT SPECIES OF THE VALAIS.] Phytopath. Z. 53 (3): 289-98. 11 refs. [F.f.g.e.] O.R.S.
Some 75 species were classed as (a) very sensitive, (b) sensitive, (c) of low sensitivity and (d) tolerant. Pinus sylvestris, Juglans regia, Acer campestre and Tilia cordata are in group (b), and Populus nigra, P. nigra var. italica and Robinia pseudoacacia in (c).

Kohut, R. 1971. THE INFLUENCE OF TIME AND POLLUTANT CONCENTRATION ON THE RESPONSE OF THREE DECIDUOUS TREE SPECIES TO OZONE. Abstr. in Phytopathology 61 (2): 130.

Kress, L. W. 1972. SYNERGISTIC EFFECT, ON HYBRID POPLAR, OF SEQUENTIAL EXPOSURES TO OZONE AND PEROXYACETYL NITRATE. [Abstract]. Phytopathology 62 (5): 496 [E.]

Steinhubel, G., and Halas, L. 1967. [DISRUPTION OF DRY-MATTER PRODUCTION AT THE INCREASED TEMPERATURES CAUSED IN LEAVES OF TREES BY NOXIOUS DUSTS.] Lesn. Cas., Praha 13 (4): 365-82. [18 refs. [Slovak.-slovak.ru.g.] 7 gphs. 8 tbls.]

425.1

Kohut, R. 1974. THE INTERACTION OF OZONE AND PAN ON HYBRID POPLAR. [Abstract]. Proceedings of the American Phytopathological Society 1 (76). [E.]

425.9

Drogoszewski, B. 1970. [THE INFLUENCE OF SIMAZIN ON ROOTING CUTTINGS OF POPULUS CV. EUR. "ROBUSTA" AND POPULUS CV. EUR. "MARILANDICA".] Hodowla Roslin Aklimatyzacja Nasiennictwo 14 (6): 525-534. [Pol.]

429 MISCELLANEOUS

Scandalios, J. G. 1964. SOME EFFECT OF X-RAYS ON ROOT PRIMORDIA IN THE POPLAR. Radiation Bot., Oxf. 4 (4): 355-9. 7 refs. O.R.S.

When cuttings from 2-year stems of Populus nigra var. italica were exposed to 250-10,000 r in a single severe treatment before being placed (in water) in the dark, the number of roots produced decreased to ca. 50% at 4000 r, and to nil at > 10,000.

44 DAMAGE BY HARMFUL PLANTS. VIRUS DISEASES

441 FOREST WEEDS

Simko, B., Gaher, S., and Barka, M. 1968. POSSIBILITY OF WEED CONTROL IN THE DANUBE BASIN. Agrochemia, Bratislava 8 (4): 103-6. [8 refs. [Slovak.ru.e.] From abstr. in Weed Abstr. 18 (4): No. 1729. O.W.]
A 5% water emulsion of 2,4,5-T butyl ester 45% + MCPA 5%, applied at 600 litres/ha., or a 10% oil emulsion, applied in July 1967 to regrowth after felling, were the most effective treatments at Podunajsky Biskupice, where the dominant Populus nigra showed > 90% control.

Stryckers, J., and Himme, M. van. 1965. [PRACTICAL RESULTS [IN WEED CONTROL RESEARCH] OBTAINED IN 1963-64.] Mededeling, Centrum voor Onkruidonderzoek, Gent No. 1, pp. 34. [Many refs. [Du.] O.W.]
Includes brief reports on the use of simazine, or diuron, plus amitrole, in 2-year windbreaks of Lombardy Poplar.

442 PARASITIC (HIGHER) PLANTS, CLIMBERS AND EPIPHYTES

Horak, O. 1974. [COMPARATIVE ANALYSES OF THE MINERAL-ION CONTENT OF SOME LORANTHACEAE AND THEIR HOSTS.] Zeitschrift fur Pflanzenphysiologie 73 (5): 461-466 [De., 13 ref. OBD]

Tronchet, J. 1972. [THE FLAVONOID CONTENT OF [GREEN] SURFACE TISSUES OF PLANTS OF VISCUM ALBUM (LORANTHACEAE) GROWN ON SIX DIFFERENT HOSTS.] Annales Scientifiques de l'Universite de Besancon, 3 (Botanique) 13, 3-7 [F., 6 ref. NLL]

443 FUNGI AND BACTERIA

Chaturvedi, C. 1972. A NEW LEAF SPOT OF POPLAR INCITED BY ALTERNARIA ALTERNATA (F.) KEISSLER. Indian Phytopathol. 25 (2): 316-318.

Meiden, H. A. van der. 1970. [DIEBACK OF LOMBARDIAN POPLAR.] Populier 7 (1): 13-14. [Du.]

Pandotra, V. R. 1971. A NEW CEREOSPORA LEAF SPOT DISEASE FROM JAMMU. Indian Journal of Mycology and Plant Pathology 1 (2): 143-144 [E.] From Review of Plant Pathology 51, 4400.
Describes a new species, C. jamuensis, on Populus nigra in northern India.

443.3

Anonymous. 1968. [POPLAR RUST.] Extr. from Rep. For. Res. Inst. Dep. For. S. Afr. 1967/68, (27). [Limited distribution.]
The occurrence of Melampsora larici-populina is reported for the first time in S. Africa, on Populus nigra var. italica throughout the S. and W. Cape and on other Poplars in Natal and the Transvaal. So far the damage is not serious.

Brendel, G. 1965. [STUDIES ON HYBRIDS OF POPULUS SECT. 'AIGEIROS' AND THEIR INFLUENCE ON THE BIOLOGY OF DOTHICHIZA POPULEA.] Phytopath. Z. 53 (1): 1-34. 2 pp. of refs. [G.g.e.] O.R.S.
Studies on the Poplar clones (a) P. 'Gelrica', (b) P. 'Regenerata Deutschland', (c) P. 'Robusta Lampertheim', (d) P. 'Leipzig' and (e) P. 'Lons' showed variations in their date and rate of flushing, and in the seasonal moisture content and amino-acid contents of the bark.

Bulatova, Z. G. 1969. THE SPREAD OF POPLAR SCAB IN UZBEKISTAN. Sborn. Nauc. Rabot. Molodyh Ucenyh Sredneaz. Nauc.-issled. Inst. Lesn. Hoz. (12), (110-2). [Ru. From abstr. in Rev. Plant Path. 1970 49 (10): No. 3019.]
Populus nigra (43-100%) and P. fastigiata [P. nigra var. italica] are severely infected by Fusicladium radiosum [Venturia macularis] at all ages, particularly in areas of high stocking. A description is given of symptoms, damage and overwintering.

Fullerton, R. A., and Menzies, S. A. 1974. EXAMINATION OF FUNGICIDES FOR CONTROL OF POPLAR LEAF RUST IN SHELTER BELTS. New Zealand Journal of Experimental Agriculture 2, 429-431 [E., 1 ref.]

Gojkovic, G., and Vujic, P. 1966. [RESULTS OF TRIALS OF SOME FUNGICIDES FOR THE CONTROL OF MELAMPSORA SPP. ON POPLARS.] Topola, Beograd 10 (59/60): 34-8. [Serb.-serb.] [2 photos. 4 tbls.]

Mocanu, V., and Tanase, I. 1968. [BIOCHEMICAL MODIFICATION OF POPULUS NIGRA VAR. THEVESTINA CAUSED BY DOTHICHIZA POPULEA.] Rev. Padurilor 83 (11): 601-3. [9 refs. [Rum.].]
Bark of infected trees showed changes in the contents of free glucosides, free and bound aminoacids, unsaturated fatty acids, chlorophyll and nucleic acids.

Quraishi, M. A., and Jamal, S. M. 1970. FUNGI ON POPULUS NIGRA LINN CV. T[H]EVESTINA IN WEST PAKISTAN. Pakistan J. For. 20 (3): 313-20. [8 refs.]

Rijkenberg, F. H. J. 1972. FINE STRUCTURE OF THE POPLAR RUST (MELAMPSORA LARICI-POPULINA). Phytophylactica 4 (2): 33-39 [E.afr.f.] From Review of Plant Pathology 52, 2383.
Reports a comparative study (with 18 figures) of the rust at different stages of its ontogeny on Populus nigra var. italica. The disease causes defoliation and occasionally death of trees in the Pietermaritzburg area, S. Africa.

Schneider, A., and Sutra, G. 1969. [THE METHOD OF INFECTION OF POPULUS NIGRA BY TAPHRINA POPULINA.] C.R. Acad. Sci., Paris 269D (12): 1056-9. [F., 3 refs. O.R.S.]
Studies in April and Dec. 1968 suggest that infection occurs in spring, when rainfall coincides with flushing, by means of spores that have overwintered on the buds.

Siwecki, R. 1969. [INVESTIGATIONS ON THE INHERITANCE OF RESISTANCE TO CHONDROPLEA (DOTHICHIZA) POPULEA BY KORNIK HYBRID POPLARS.] Arboretum Kornickie, Poznan 14, (219-74). [Pol.e.ru., 44 refs.]

Solov'ev, A. M. 1964. [THE INFLUENCE OF TISSUE SAPS OF TREE AND SHRUB SPECIES ON MYCELIUM OF FOMES ANNOSUS.] Bot. Z. 49 (11): 1652-5. 23 refs. [Ru.]

Urosevic, B. 1972. [THE OCCURRENCE OF HYPOXYLON CANKER OF POPLARS IN CZECHOSLOVAKIA.] Prace Vyzkumncho Ustavu Lesniho Hospodarstvi a Myslivosti 42, 119-128 [Cs.ru.e., 16 ref.]

Zalasky, H. 1964. DIPLODIA TUMEFACIENS (MACROPHOMA TUMEFACIENS), THE CAUSE OF GALLS AND ROUGH-BARK IN POPLAR. Abstr. in Proceedings, 30th Session of the Canadian Phytopathological Society, Fredericton 1964 No. 31, (16). I.M.I.
Describes the development of galls and fissured bark on Black Poplar in inoculation trials. The fungus penetrated through intact cuticle and epidermis into periderm and outer cortex, stimulating meristematic activity in phellogen and cortex.

444 VIRUS DISEASES

Kraus, H. 1973. [COMPARATIVE STUDIES OF A GERMAN AND AN ITALIAN ISOLATE OF POPLAR MOSAIC VIRUS.] Wissenschaftliche Abhandlung, Botanisches Institut der Universitat des Saarlandes, Saarbrucken. 48 pp. [De., 27 ref.]
Discusses the collection of foliage with Poplar mosaic virus symptoms from Populus 'Serotina', P. 'Marilandica' and, chiefly, P. 'Robusta' in the Saarland, and the isolation and characterization of the causative virus.

45 DAMAGE BY ANIMALS

451 MAMMALS

Anonymous. 1970. REPORT OF THE INTERNATIONAL CONFERENCE ON RODENTS: MICROTUS, ARVICOLA AND OTHER RODENTS AFFECTING AGRICULTURE AND FORESTRY. (HELSINKI-OTANIEMI, 1-3 SEPT. 1969). Publications de l'OEPP [Organisation Europeenne et Mediterraneenne pour la Protection des Plantes]. A No. 58, 250 pp. [E.f., many ref.]

453 INSECTS

Anonymous. 1974. [INSECT DESTROYERS OF WOOD IN THE FOREST BIOCOENOSES OF THE SOUTHERN MARITIME PROVINCE.] Moscow, USSR; Nauka. 128 pp. [Ru., many ref. Bl L.]
A collection of 12 papers on insect destroyers of wood in various forest communities of the Soviet Far East.

Allen, A. A. 1966. STEGOBIUM PANICEUM L. (COL.) (ANOBIIDAE) BECOMING ESTABLISHED IN THE OPEN? Ent. mon. Mag. 101 (1211/1213): 115. 2 refs.
Reports finding odd specimens of this beetle, normally infesting non-woody substances in houses or stores, on Lombardy Poplars in S.E. London, twice on the foliage and once on the trunk.

Boccone, A. 1971. [NOTES ON HONEYDEW ON POPLARS ATTACKED BY CHAITOPHORUS VERSICOLOR (HOMOPTERA: APHIDIDAE) AND ON ITS COMPOSITION.] Cellulosa e Carta 22 (10): 43-5. [It.f.e.de., 7 ref.]

Dixon, A. F. G. 1973. BIOLOGY OF APHIDS. London, UK, Edward Arnold. 5 + 58 pp. + 4 pl. ISBN 0-7131-2421-0 [E., 70 ref. (Studies in Biology No. 44), Price £1.50]

Halanskaja, L. P. 1968. [NEW DATA ON CAPNODIS MILIARIS METALLICA.] Lesn. Hoz. (11), (57-8). [Ru.]
Brief notes on this buprestid borer of the butt and larger roots of Poplars in Uzbekistan. Populus alba is badly infested; P. nigra is almost immune.

Herfs, W. 1973. [STUDIES ON THE BIOLOGY OF PEMPHIGUS BURSARIUS.] Zeitschrift fur Angewandte Entomologie 74 (3): 225-245 [De.e., 29 ref. OH]
Describes investigations in W. Germany with special reference to the flask-shaped galls formed at the base of the petioles of Populus nigra (especially P. nigra var. italica), the primary host of P. bursarius, which has recently become a serious pest of vegetable crops in several regions.

Inouye, M. [Inoue, M.] 1972. STUDIES ON THE BIOLOGY OF ETEOPHILUS NOTAROIDES KONO FEEDING ON POLLEN OF POPULUS MAXIMOWICZII (COLEOPTERA CURCULIONIDAE). Technical Note, Oji Institute For Forest Tree Improvement No. 125, 2 pp. [E.Jap.]
Describes the life cycle of E. notaroides [cf. FA 29, 6008] in Hokkaido, where the larvae feed on immature pollen in male flowers of P. maximowiczii in spring, and concludes that this pest may cause a loss of pollen sufficiently serious to affect tree-breeding programmes.

Inou(y)e, M., and Morimoto, K. 1968. [STUDIES ON THE MORPHOLOGY AND BIOLOGY OF ETEOPHILUS NOTAROIDES (KONO) FEEDING ON POLLEN OF POPULUS MAXIMOWICZII.] J. Jap. For. Soc. 50 (2): 33-7. [2 refs. [Jap.e.].]

Keller, T. 1964. [THE EFFECT OF LEAF MINERS ON PHOTOSYNTHESIS AND TRANSPIRATION OF POPLAR LEAVES.] Z. PflKrankh. 71 (11/12): 667-71. 6 refs. [G.g.e.] E.M.B.
A light attack (up to 10% of the leaf-blade affected by mining) did not affect photosynthesis, but increased transpiration by 17%. Severe attack (30-50% of the leaf-blade) reduced photosynthesis by 20% and transpiration by 22% at 40,000 luxes.

Kovacs, L. 1970. [BIOLOGY OF CLOSTERA (PYGAERA) ANASTOMOSIS IN HUNGARY, AND THE OUTBREAK OF 1963/1964.] Erdesz. Kutatas. 66, (147-54). [De., 5 ref.]

Nastase, I. 1974. [THE INFLUENCE OF TEMPERATURE ON THE DEVELOPMENT OF EUPROCTIS CHRYSORRHOEA DURING THE [WINTER] REST PERIOD OF VEGETATION.] Revista Padurilor-Industria Lemnului, Silvicultura si Exploatarea Padurilor 89 (2): 100 [Ro.]

5 FOREST MENSURATION

52 MEASUREMENTS OF STEM DIMENSIONS AND VOLUME OF TREES, STANDS, FORESTS AND TIMBER

524 DETERMINATION OF THE VOLUME, ETC.

Ferreira, Rojas O. 1973. [COMPILATION OF VOLUME TABLES FOR NATIVE [CHILEAN] SPECIES.] Informe Tecnico, Instituto Forestal, Chile No. 43, 56 pp. [Es.e.]
Gives bd-ft volume tables for 14 native Chilean species (softwoods and hardwoods), and ft^3 volume tables for the same 14 species and also for Populus nigra and Eucalyptus globulus.

Hussain, R. W., and Cheema, M. A. 1973. PROVISIONAL VOLUME TABLES FOR POPLAR (POPULUS NIGRA) IN MARDAN. Pakistan Journal of Forestry 23 (1): 64-73 [E., 4 ref.]
Presents a standard volume table and a local volume table for this region of Pakistan showing volume o.b. for diameters 2,3,4...15 in, with the regression equations and an account of the construction of the tables.

Red'ko, G. I. 1972. [BIOMASS OF ABOVE-GROUND PARTS IN STANDS OF POPULUS EURAMERICANA AND THEIR AMOUNTS OF NITROGEN AND ASH.] Lesovod Agrolesomelior 30: 84-92. [Ru.]

525 VOLUME BY ASSORTMENTS, ETC.

Losickij, K. B., and Carkina, A. P. 1965. [ASSORTMENT VOLUME TABLES FOR POPULUS NIGRA.] Izdatel'stvo 'Lesnaja Promyslennost', Moscow. pp. 75. [Ru.] Many tbls.
The tables are for three height-classes, viz. 14-37, 11-34, and 8-31m., and d.b.h. 8-152 cm. in each class.

526 LOG MEASUREMENT, ETC.

Lee, C. K. 1973. PREPARATION OF STEM VOLUME TABLES FOR FIVE SPECIES BESIDES ITALIAN POPLAR (POPULUS EURAMERICANA). Res. Rep. For. Res. Inst. No. 20, 35-92.

56 INCREMENT; DEVELOPMENT AND STRUCTURE OF STANDS

Giordano, E. 1974. [PRELIMINARY NOTES ON SHORT-ROTATION COPPICE MANAGEMENT OF POPULUS 'I-214'.] Cellulosa e Carta 25 (9): 5-9 [It.f.e.de., 6 ref.]

Levickij, I. I. 1965. [DIAMETER STRUCTURE OF BASHKIRIAN POPULUS NIGRA STANDS.] Lesn. Z., Arhangel'sk 8 (2): 39-41. [Ru.] 3 tbls.
Tabulates data for pure high-forest stands ranging in mean diameter from 17.9 to 78.4 cm.

Mirkovic, D. 1968. [STRUCTURAL FEATURES OF A TRIAL PLANTATION OF POPULUS X MARILANDICA.] Jelen, Beograd (7), (39-54). [9 refs. [Serb.ru.e.].]

6 FOREST MANAGEMENT

65 SPECIAL BUSINESS PROBLEMS OF TIMBER GROWING

Floricica, N. 1971. [THE ECONOMICS OF ARTIFICIAL PRUNING OF HYBRID BLACK POPLARS.] Rev. Padurilor 86 (12): 627-8. [Ro.]
A note based on a study of Rumanian stands of Populus 'Marilandica' at rotation age (20 years), showing that the increased value of wood assortments in a regularly pruned stand, compared with an unpruned stand, was > 5 times the total (uncompounded) costs of pruning.

8 FOREST PRODUCTS AND THEIR UTILIZATION

81 WOOD AND BARK: STRUCTURE AND PROPERTIES

Borak, M., and Necesany, V. 1967. CHANGES IN THE FORMATION OF THE LIGNIFIED CELL WALL WITHIN A TWENTY-FOUR HOUR PERIOD. Biol. Plant., Praha 9 (3): (195-201 + 2 plates). [13 refs. [E.e.slovak.ru.] O.R.E.]
Results confirm that lignin permeates through the cellulosic part of the wall formed previously, impregnates it, and cements it to the preceding lamella.

810 GENERAL INFORMATION ON WOODS

Anonymous, 1969. [TECHNOLOGICAL DATA. THE MAIN COMMERCIAL TIMBERS OF THE WORLD: POPULUS NIGRA; ACACIA MELANOXYLON.] Bol. Inform. tec. Asoc. Invest. Tec. Ind. Madera, Madrid 7 (36): 29-36. [[Span.] P.R.]

Anonymous. 1972. [INVESTIGATION OF THE WOOD PROPERTIES OF SELECTED TUNISIAN TREE SPECIES.] Prace Instytutu Technologii Drewna 19 (1/2): 145-164 [Pol.ru.e., PR]
Populus [nigra var.] is included.

Pojoski, B. 1964. [TECHNICAL PROPERTIES OF THE WOOD OF POPULUS NIGRA VAR. THEVESTINA.] Cellulosa e Carta 15 (7): 14-6. [It.f.e.g.]

811 STRUCTURE. IDENTIFICATION.

Anonymous. 1970. [Dimensions of libriform fibres in some stems of Populus 'Gelrica'.] Report H 70-72 Houtinstituut TNO (Forest Products Research Institute TNO), Delft. [Du.]

Anonymous. 1971. [ANATOMICAL RESEARCH ON THE DIMENSIONS OF LIBRIFORM FIBRES IN SOME STEMS OF POPULUS 'OXFORD'. Report H 71-28 Houtinstituut TNO (Forest Products Research Institute TNO), Delft. [Du.]

Simic, P. 1964. [ANATOMICAL STRUCTURE OF THE WOOD OF INDIGENOUS PYRAMIDAL POPLARS (POPULUS NIGRA VAR. ITALICA AND P. THEVESTINA) FROM JUGOSLAVIAN MACEDONIA.] God. Zborn. Zemj.-Sum. Fak. Univ. Skopje (Sum.) No. 17, 1963/1964. (183-233). [56 refs. [Serb.g.g.].]

Simic, P. 1965. [ANATOMICAL STRUCTURE OF THE WOOD OF INDIGENOUS PYRAMIDAL POPLARS (POPULUS NIGRA VAR. ITALICA AND P. THEVESTINA) FROM JUGOSLAVIAN MACEDONIA. PART 2.] God. Zborn. Zemj.-Sum. Fak. Univ. Skopje (Sum.) No. 18, 1964/1965 (99-154). [66 refs. [Serb.g.g.].]

Simic, P. 1965. [THE ANATOMICAL STRUCTURE OF THE WOOD OF POPULUS NIGRA VAR. ITALICA AND P. [NIGRA VAR.] THEVESTINA FROM MACEDONIA.] Arch. Forstw. 14 (11/12): 1271-84. 8 refs. [G.g.ru.e.]

811.1

Kucera, L., and Necesany, V. 1970. THE EFFECT OF DORSIVENTRALITY ON THE AMOUNT OF WOOD RAYS IN THE BRANCH OF FIR (ABIES ALBA MILL.) AND POPLAR (POPULUS MONILIFERA HENRY). PART I. SOME WOOD RAY CHARACTERISTICS. Drev. Vyskum (1), (1-6). [E.slovak.g., 12 refs. P.R.]

Necesany, V. 1966. [CHANGES IN THE VITALITY OF PARENCHYMA CELLS AS THE PHYSIOLOGICAL BASIS OF HEARTWOOD FORMATION.] Holzforsch. u. Holzverwert., Wien 18 (4): 61-5. [21 refs. [G.g.e.] P.R.]
In stems with all sapwood (s.w.) or s.w. plus ripewood (r.w.), vitality declined (but not to zero) towards the pith, decrease being rapid at the s.w./r.w. border.

Necesany, V. 1971. EFFECT OF SOME ENVIRONMENTAL FACTORS ON THE CELL WALL STRUCTURE. Holzforschung 25 (1): 4-8. [E.de., 17 ref. PR]

Necesany, V. 1971. THE EFFECT OF PHOTOPERIOD AND SOIL MOISTURE ON THE CELL WALL FORMATION. Drevarsky Vyskum 16 (3): 135-145 + 1 pl. [E.cs.de.ru., 20 ref. PR]

Necesany, V. 1974. CIRCADIAN PHYSIOLOGICAL RHYTHM OF SECONDARY CELL WALL FORMATION. Drevarsky Vyskum 19 (2): 55-69 + 1 pl. [E.cs.ru.de., 35 ref. BLL]
Electronmicroscope investigations were made on Populus nigra var. italica, Pinus strobus and Eucalyptus radiata to determine the corresponding pattern of variation in time of ten biochemical features characterizing the process of secondary-wall formation.

Necesany, V., et al. 1965. FORMATION OF LIGNIFIED CELL WALLS WITHIN TWENTY-FOUR HOURS. Nature, Lond. 206 (4984): 639. 6 refs.
Chemical analysis has shown that during 24 hr. the biochemical nature of cells in the cambial zone and in the youngest secondary xylem of 15-year-old Populus nigra is continually changing. Cellulosic lamellae are formed during the afternoon and lignification occurs after midnight.

Necesany, V., and Jokel, J. 1972. [CHANGES IN THE STRUCTURE OF POPLAR WOOD CAUSED BY RADIATION.] Drevarsky Vyskum 17 (1): 3-8 + 8 pl. [Cs.ru.de.e., 15 ref.]

Yata, S., Itoh, T., and Kishima, T. 1970. FORMATION OF PERFORATION PLATES AND BORDERED PITS IN DIFFERENTIATING VESSEL ELEMENTS. Wood Res. No. 50, (1-11). [E., 13 refs.]
Describes and illustrates stages in the decomposition of the end walls and pit membranes of maturing vessel elements observed in wood sections (1-5 μ thick) of Populus nigra var. italica.

811.12

Casperson, G., Jacopian, V., and Philipp, B. 1967. [CHANGES IN THE ULTRASTRUCTURE OF POPLAR WOOD IN THE COURSE OF VARIOUS PULPING PROCESSES.] Svensk PappTidn. 70 (21): 702-10. [10 refs. [G.g.sw.e.] 18 photos. 2 tbls. [Deutsche Akademie der Wissenschaften zu Berlin].]
Illustrated by photomicrographs.

811.2

Hasegawa, Y., Yamada, T., and Sumiya, K. 1970. [FORMATION OF WOOD UNDER RESTRAINT AND PROPERTIES OF THE WOOD.] Wood Res. No. 49, (1-17). [Jap.e., 23 refs.]

811.5

Watanabe, H., Matsumoto, T., and Hayashi, H. 1966. [STUDIES ON JUVENILE WOOD. III. EXPERIMENT ON STEMS OF POPLAR, SHUNOKI AND MIZUNARA.] J. Jap. Wood Res. Soc. 12 (6): 259-65. [10 refs. [Jap.e.e.] P.R.]
It is concluded that there is less difference in quality between m.w. and j.w. in hardwoods than in softwoods.

Yazawa, K., Ishida, S., and Miyajima, H. 1965. ON THE WET-HEARTWOOD OF SOME BROAD-LEAVED TREES GROWN IN JAPAN. J. Jap. Wood Res. Soc. 11 (3): 71-6. 18 refs. [E.e.jap.] P.R.
Though wetwood in conifers has usually been considered an abnormality, the wet heartwood here described in broadleaved species appears to be quite normal.

812 PHYSICAL AND MECHANICAL PROPERTIES

Anonymous. 1968. [SOME PHYSICAL AND OTHER PROPERTIES OF THREE STEMS OF POPULUS 'OXFORD'.] Report H 68-82 Houtinstituut TNO (Forest Products Research Institute TNO), Delft. [Du.]

Anonymous. 1971. [SOME PHYSICAL AND OTHER PROPERTIES OF THREE STEMS OF POPULUS 'OXFORD'.] Report H 71-52 Houtinstituut TNO (Forest Products Research Institute TNO), Delft. [Du.]

Curro, P., and Sertmehmetoglu, Z. 1965. [SOME INVESTIGATIONS ON POPULUS NIGRA IN CENTRAL ANATOLIA.] Tek. Yay. Kavak. Arast. Enst., Izmit No. 1. pp. 30. [Turk.]

Pejoski, B., and Nicota, B. 1964. [STUDIES ON POPULUS NIGRA VAR. THEVESTINA IN CERTAIN PLACES IN MACEDONIA.] Godisn. Sum. Inst., Skopje 6, 1962-1963. (3-50 + 11 photos). 19 refs. [Maced.f.] P.R.

812.2

Cop, D. 1974. [THE PERMEABILITY AND CAPILLARY POROUS STRUCTURE OF THE WOOD POPULUS 'MARILANDICA'.] Holztechnologie 15 (3): 176-183 [De.e.ru., 18 ref. PR]
A positive linear correlation between permeability and proportion of vessels, and a negative correlation between permeability and sp. gr., were found.

Filipovici, J., and Poscarus, P. 1969. [THE DYNAMICS OF SWELLING IN SPRUCE, BEECH, AND POPLAR WOOD OF DIFFERENT THICKNESSES, IN VARIOUS MEDIA (WATER, ACETIC ACID 10%, SODIUM HYDROXIDE 10%).] Industr. Lemn. 20 (4): 133-8. [4 refs. [Rum.ru.g.f.e.].]
Presents the results of tests on wood 0·75-10·00 mm. thick. Speed of swelling was shown to depend on thickness of the wood. Swelling was greater in the tangential than in the radial direction, irrespective of the liquid used.

812.7

Bucur, V., Stefanescu, D., and Pascu, A. 1973. [DETERMINING MODULI OF ELASTICITY BY MEASURING THE DEFORMATIONS OF POPULUS NIGRA WOOD WITH TENSOMETRIC TRANSDUCERS MOUNTED ON PAPER.] Industria Lemnului 24 (7) 261-266 + smries. [Ro.f.ru.e.de., 14 ref.]
Mean values of the moduli ranged from 80,000 kgf/cm^2 on the tangential face in compression, to 110,000 kgf/cm^2 on the radial face in tension.

Pozgaj, A. 1971. [THE SHEAR MODULI OF WOOD.] Drevarsky Vyskum 16 (4): 237-250 [Sk.ru.de.e., 13 ref. PR]
Reports tests on specimens of Fraxinus excelsior, Populus 'Marilandica' and Picea abies.

Pozgaj, A. 1972. [ELASTIC CONSTANTS OF POPULUS 'MARILANDICA' WOOD.] Drevarsky Vyskum 17 (3): 165-173. [Sk.ru.de.e., 15 ref.]
Gives comparative values for P. 'Marilandica' and Picea Abies.

Pozgaj, A. 1972. [ELASTIC DEFORMATIONS OF WOOD IN RELATION TO ITS MACROSCOPIC STRUCTURE.] Zbornik Vedeckych Prac Drevarskej Fakulty Vysokej Skoly Lesnickej a Drevarskej vo Zvolene 299-306 [Sk.ru.de., 8 ref.]
Tabulates and briefly discusses results from tests made on specimens of Fraxinus excelsior, Populus 'Marilandica' and Picea abies comparing their patterns of elastic deformation under compression load.

Pozgaj, A. 1973. [INTER-RELATIONS BETWEEN THE ELASTIC CONSTANTS OF WOOD REGARDED AS AN ORTHOTROPIC MATERIAL AND ITS MOISTURE CONTENT.] Drevarsky Vyskum 18 (1): 57-69 [Sk.ru.de.e., 15 ref. PR]
Results, given in graphs, demonstrate the increase in the value of elastic constants with increasing m.c. up to fibre-saturation point and the mechanism of the effect of water penetration on molecular structure is discussed briefly.

Pozgaj, A. 1974. [CORRECTION FACTORS FOR MODULI OF ELASTICITY IN COMPRESSION AS A FUNCTION OF MOISTURE CONTENT.] Drevarsky Vyskum 19 (2): 83-92 [Sk.ru.de.e., 14 ref. BLL]

813 WOOD CHEMISTRY

813.1

Dudkin, M. S., Tatarkina, G. V., and Kazanskaya, I. S. 1971 [STRUCTURE OF THE XYLANS OF WOOD OF A POPLAR AND A EUCALYPT.] Khim. Drev. No. 8, (23-6). [Ru., 6 ref. PR]
The xylans were similar and were found to be 4-O-methylglucuronoxylans with a branched structure built up for D-xylose and uronic-acid residues.

Koblitz, H. 1964. [THE BIOCHEMISTRY OF THE PLANT CELL-WALL.] Abstr. in Ber. Dtsch. Bot. Ges. 77 (9): 391-5. 21 refs. [G.] O.B.D.
Investigations on 1-year-old shoots of Pinus sylvestris, P. strobus, Abies alba, Populus nigra, Aesculus hippocastanum and Tilia cordata showed that the principal redoxase involved in lignification of the cell-wall is cytochrome oxidase.

Koblitz, H., and Koblitz, D. 1964. PARTICIPATION OF CYTOCHROME OXIDASE IN LIGNIFICATION. Nature, Lond. 204 (4954): 199-200. 7 refs.
It is suggested that the principal redoxidase involved in lignification in higher plants is cytochrome oxidase.

Shimada, M., Ohashi, H., and Higuchi, T. 1970. O-METHYL TRANSFERASES INVOLVED IN THE BIOSYNTHESIS OF LIGNINS. Phytochemistry 9 (12): 2463-70. [22 refs. O.R.S.]
Results suggest that syringyl compounds are not necessary for the formation of gymnosperm lignins and that gymnosperms may lack the enzyme systems participating in the formation of syringyl lignin found in angiosperms. The significance of the metabolic difference is discussed.

Venverloo, C. J. 1969. THE LIGNIN OF POPULUS NIGRA L. CV 'ITALICA'. A COMPARATIVE STUDY OF THE LIGNIFIED STRUCTURES IN TISSUE CULTURES AND THE TISSUES OF THE TREE. Acta bot. neerland. 18 (2): 241-314. [4 pp. of refs. [E.e.] O.B.D.]

813.3

Ginzel, W. 1972. [THE BEHAVIOUR OF SOME ACCESSORY COMPONENTS OF SEVERAL HARDWOOD SPECIES UNDER THE INFLUENCE OF ALKALINE AND/OR ALKALINE-OXIDIZING SOLUTIONS.] Papier 26 (6): 305-311 [De.e.f., 29 ref. PO]

813.9

Labsky, O. 1974. [CHANGES IN THE pH VALUE OF WOOD AFTER TREATMENT WITH AMMONIA.] Drevarsky Vyskum 19 (3): 125-135 [Sk.ru.de.e., 18 ref. BLL]
In general, treatment causes the pH values of naturally acidic species to increase to neutrality, while those of naturally alkaline species remain unchanged or increase slightly. The decrease in pH caused by drying is greater for treated than for untreated wood.

Zenkteler, M., and Wozniak, H. 1965. [pH OF WOOD OF CERTAIN POLISH TREE SPECIES.] Sylwan 109 (2): 49-53. 9

refs. [Pol.ru.e.]
Tabulated pH values are presented for 15 Polish species, separately for sapwood and heartwood where appropriate. Populus nigra heartwood had the highest pH (7.36). Heartwood was not always more acid than sapwood.

815 EFFECT OF GROWTH FACTORS ON STRUCTURE AND PROPERTIES

Homenko, E. I. 1968. [METHOD OF DETERMINING THE TECHNICAL PROPERTIES OF POPLAR WOOD IN VARIETY TESTING.] Lesn. Z., Arhangel'sk 11 (2): 91-4. [Ru.]
Presents an accelerated method of selecting Poplars on the basis of wood properties at age 5 years.

83 TIMBER MANUFACTURING INDUSTRIES AND PRODUCTS

BenSalem, B., and Charfi, M. 1974. [CAN STAKES BE PRODUCED IN IRRIGATED AREAS?] Bulletin d'Information, Institut National de Recherches Forestieres, Tunisia No. 17, 3-8 [F.]

Burgos, J. C., and Arreghini, R. I. 1968. [PRELIMINARY TRIAL IN SAWING POPULUS NIGRA VAR. ITALICA, WITH SAWS USED LOCALLY IN MENDOZA, FOR THE PRODUCTION OF WOOD FOR CARPENTRY AND BOX-MAKING.] Rev. for argent. 12 (2): 52-5. [Span.span.]

Nikolov, S., and Abrasev, G. [Abrashev, G.] 1974. [IMPROVING THE CHARACTERISTICS OF POPLAR PLYWOOD BY MODIFICATION OF THE FACE VENEER.] Topola 18/19 (103/106): 99-107. [Sh.e.ru., 8 ref.]

84 PRESERVATION AND OTHER TREATMENTS TO IMPROVE THE PROPERTIES OF WOOD. DAMAGING INFLUENCES

842 TREATMENTS TO IMPROVE THE RESISTANCE OF WOOD TO PHYSICAL AND CHEMICAL AGENCIES

Jokel, J., and Pullmann, M. 1973. [INFLUENCE OF WOOD MOISTURE CONTENT ON THE PROPERTIES OF POLYMERIZED WOOD.] Drevarsky Vyskum 18 (4): 197-210 [De.sk.ru.e., 7 ref. BLL]
High (15%) m.c. improved dimensional stability, but reduced toughness and increased brittleness considerably.

Jokel, J., Pullmann, M., and Necesany, V. 1974. [THE DEPOSITION OF SYNTHETIC POLYMER IN WOOD/PLASTIC COMPOSITES (WPC).] Drevarsky Vyskum 19 (1): 23-27 + 5 pl. [Sk.ru.de.e., 9 ref. BLL]
In WPC based on the pure monomer, the polymer filled the empty lumina, and did not penetrate the cell-walls, while in the emulsion-based products hardly any was found in the lumina and it was assumed to be located mainly in the cell-walls.

Katuscak, S., Horsky, K., and Zatopkova, L'. 1972. SWELLING OF WOOD IN ORGANIC LIQUIDS USED FOR PRODUCTION OF WOOD/PLASTIC COMBINATIONS. Drevarsky Vyskum 17 (2): 111-124 [E.sk.ru.de., 9 ref. PR]
The degree of swelling was in the increasing order: styrene, butyl methacrylate, ethyl methacrylate, cyclohexyl methacrylate, methyl methacrylate, vinyl acetate, acrylonitrile, and water.

Luzakova, V., Reiser, V., and Kosik, M. 1974. [FREE RADICAL CHAIN POLYMERIZATION OF VINYL MONOMERS IN WOOD IN SITU WITH REFERENCE TO ACCESSORY CONSTITUENTS OF WOOD.] Holzforschung 28 (1): 1-4 [De.e., 6 ref. BLL]
The greatest inhibitory and retarding effect on polymerization was observed in the fractions that contained low-molecular phenolic compounds that were soluble over the wide range of polarities of the solvents used.

Pullmann, M., and Jokel, J. 1972. APPLICATION OF METHYL METHACRYLATE WATER EMULSIONS FOR PREPARING WOOD-PLASTICS BY RADIATION PROCESSING. Drevarsky Vyskum 17 (4): 231-245 [E.sk.ru.de., 18 ref. PR]

Varga, S., and Piatrik, M. 1971. [PREPARATION OF POPLAR-WOOD MODIFIED WITH STYRENE.] Zb. Prac Chem. Fak. SVST 109-117 [Sk.ru.de., 5 ref.] From Abstract Bulletin of the Institute of Paper Chemistry 44, 2901. LTP.
Wood modified with styrene had substantially reduced water sorption capacity, and the curves of swelling against time show that the styrene treatment slowed down the rate of swelling and reduced the maximum swelling.

844 ATTACK BY PLANT ORGANISMS

844.2

Igmandy, Z., and Pagony, H. 1966. [DURABILITY OF WOOD OF POPLAR HYBRIDS OF THE SECTION AIGEIROS.] Erdesz. Kutatas., Budapest 62 (1/3): 269-77. [11 refs. [Hu.ru.g.].]
In decay tests with 5 wood-destroying fungi, there was little difference between the hybrid Poplars cvs. 'Regenerata', 'Serotina', 'Marilandica', 'Robusta' and 'I-214', and Populus nigra cv. 'H. 418', nor between heartwood and sapwood. Durability was uniformly low.

845 ATTACK BY ANIMALS

845.2

Kervina, L. 1967. [HYLOTRUPES BAJULUS: ONE OF THE MOST DANGEROUS PESTS OF CONVERTED TIMBER.] Gozd. Vestn. 25 (1/2): 15-22. [5 refs. [Sloven.g.].]

845.3

Repka, P., Svecova, M., and Majek, M. 1974. [POSSIBILITIES FOR THE DRYING AND INDUSTRIAL USE OF THICK VENEER.] Drevo 29 (6): 169-172 + smries. [Sk.ru.de.e., 7 ref. PR]

847 DRYING (SEASONING)

Repka, P., Ross, R., and Svecova, M. 1973. [THE TECHNOLOGY OF DRYING THICK PEELED VENEER.] [Publication,] Statny Drevarsky Vyskumny Ustav No. 28, 24 pp. + 4 tab. [Sk.e.de.ru., 6 ref. TRADA]

85 "GRADING" OF WOOD AND WOOD PRODUCTS

852 DETECTION, RECOGNITION AND ASSESSMENT OF INJURIES AND DEFECTS

Chovanec, D. 1971. [THE INFLUENCE OF DISEASES OF POPLAR STANDS ON THE QUALITY OF POPLAR ROUNDWOOD.] Zbornik Vedeckych Prac Drevarskej Fakulty Vysokej Skoly Lesnickej a Drevarskej vo Zvolene 87-98 [Sk.ru.de., 9 ref.]

Chovanec, D. 1971. [THE INFLUENCE OF BRANCHINESS ON THE QUALITY OF POPLAR ROUNDWOOD FROM UNTENDED STANDS.] Zbornik Vedeckych Prac Drevarskej Fakulty Vysokej Skoly Lesnickej a Drevarskej vo Zvolene 99-114 [Sk.ru.de., 8 ref.]

86 PULP INDUSTRIES

Chawla, J. S., and Sharma, A. N. 1972. HARDWOODS FOR PAPER. Indian Pulp Pap. 26 (8/9): 116-118.

861 PULP AND PAPER MANUFACTURE. TEXTILE AND OTHER CELLULOSE DERIVATIVES

Christensen, K., Valtchev, V., Christova, E., Dimitrova, L., and Neikova, K. 1971. BLEACHING OF VISCOSE PULP FROM POPLAR WOOD. Papir a Celuloza 26 (12): 125-132 [E., 8 ref.] From Cellulosa e Carta 24 (4) 58-59. It.
Gives comparative data on the chemical properties of bleached sulphate pulps made, by various procedures, from the heartwood and the sapwood of Poplar (Populus 'Regenerata').

Ginzel, W., Saad, S. M., and Stegmann, G. 1969. PREPARATION OF SEMICHEMICAL PULP FROM HARDWOOD IN AN ALKALINE OXIDISING SOLUTION CONTAINING WATER GLASS. Institute of Paper Chemistry, Appleton, Wis. [Transl. from Holzforschung 23 (5): 152-63.]

Meinecke, A. 1972. PRODUCTION OF BLEACHED REFINER GROUNDWOOD FROM HARDWOODS. Pulp & Paper Magazine of Canada 73 (7): 80-85 [E., 8 ref.]

In pilot-plant tests, with different impregnation methods, usable fibrous pulps were produced from Populus 'Marilandica' and Betula verrucosa.

Nikolova, M. 1972. [CHEMICAL AND TECHNOLOGICAL PROPERTIES OF POPULUS REGENERATA WOOD.] Tseluloza Khartiya 3 (3): 16-21. [Bulg., 13 ref.] From Abstract Bulletin of the Institute of Paper Chemistry 43, 7399. LTP.
Gives data for sapwood and heartwood of trees 10, 15, and 20 years old in Bulgaria, with reference to suitability for the manufacture of dissolving pulp.

Nikolova, M. 1973. [DETERMINATION OF OPTIMUM CONDITIONS FOR AQUEOUS PREHYDROLYSIS OF POPULUS REGENERATA WOOD.] Tseluloza Khartiya 4 (3): 7-14 [Bulg., 16 ref.] From Abstract Bulletin of the Institute of Paper Chemistry 44, 7245. LTP.
Optimum conditions were a water : chip ratio of 4 : 1, temperature 170° C, and a time sufficient to increase the prehydrolysate acidity to 14 cm^3 0.1 N NaOH/10 cm^3.

Nikolova, M., Vulchev, V., Draganova, R., and Khristova, E. 1971. [MANUFACTURE AND BLEACHING OF VISCOSE-GRADE PULP FROM POPLAR WOOD.] Tseluloza Khartiya 2 (4): 4-7 [Bulg., 6 ref.] From Abstract Bulletin of the Institute of Paper Chemistry 42, 11320. LTP.
Pulp yield was 42.6% from sapwood and 43.7% from heartwood. Both types of pulp were suitable for the production of viscose (except that the pentosan content of the heartwood pulp was slightly too high).

862 COMPOSITE MATERIALS MADE WHOLLY OR PARTLY OF WOODY MATTER

Kehr, E., and Schilling, W. 1965. [STUDIES ON THE SUITABILITY OF VARIOUS SPECIES AND CATEGORIES OF WOOD FOR PARTICLE-BOARD MANUFACTURE. 7. OAK, ASPEN, POPLAR, HORNBEAM, ELM, AND LARCH, WITH SPRUCE AND SCOTS PINE FOR COMPARISON.] Holztechnol., Dresden 6 (4): 225-32. 27 refs. [G.g.ru.e.] P.R.
Discusses certain manufacturing and strength characteristics of some or all of the above species when used in one- and three-layer boards made with urea-formaldehyde.

Sattler, H. 1965. [THE EFFECT OF SOME WOOD PROPERTIES ON THE MANUFACTURE OF CEMENT-BOUND WOOD-WOOL BUILDING SLABS.] Holztechnol., Dresden 6 (4), (265-8). 8 refs. [G.g.ru.e.] P.R.

863 WOOD HYDROLYSIS

Brabec, J., and Szalai, P. 1973. [CHARACTERISTICS OF HARDWOOD PREHYDROLYZATES.] Vyskum. Prace Odboru Papiera Celulozy No. 18, V 57-V 60 [Sk.e.de.ru., 7 ref.] From Abstract Bulletin of the Institute of Paper Chemistry 44, 12111. LTP.
Weight loss was highest in Hornbeam, Birch and Beech, and lowest in Alder and Poplar.

9 FORESTS AND FORESTRY

FROM THE NATIONAL AND INTERNATIONAL POINTS OF VIEW

90 GENERAL

Wolterson, J. F. 1974. [POPULUS NIGRA IN THE NETHERLANDS.] Populier 11 (2,3): 33-36, 52-55. [Du.]

97 INTERNATIONAL FOREST POLICY AND OTHER INTERNATIONAL COLLABORATION

Curro, P., and Sertmehmetoglu, Z. 1965. SUR LA CONNAISSANCE DU POPULUS NIGRA. 12th Sess. FAO/CIP, Teheran. [Turk.]

P. ROBUSTA TO P. SUKASHEWI

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

11 SITE FACTORS: CLIMATE, SITUATION, SOIL, HYDROLOGY

Burg, J. van den. 1972. [MINERAL NUTRITION OF POPULUS 'ROBUSTA'.] Internal Report nr. 7, Forest Research Station, Wageningen. [Du.]

16 GENERAL BOTANY

160 PLANT CHEMISTRY

Chardenon, J. 1967. [STUDYING THE GASEOUS EMANATIONS OF VARIOUS POPLAR ORGANS.] Bull Serv. Cult. Etud. Peuplier et Saule, Paris (1/2), (59-60). [F.]

Hewett, E. W., and Wareing, P. F. 1973. CYTOKININS IN POPULUS X ROBUSTA SCHNEID: A COMPLEX IN LEAVES. Planta 112 (3): 225-233 [E., 23 ref. OBD]

Hewett, E. W., and Wareing, P. F. 1973. CYTOKININS IN POPULUS X ROBUSTA (SCHNEID): LIGHT EFFECTS ON ENDOGENOUS LEVELS. Planta 114 (2): 119-129 [E., 26 ref. OBD]
Reports experiments with mature leaves on 1-year-old cuttings and potted seedlings, and on detached leaves, showing that the cytokinin contents increase transiently after short periods of exposure to red light.

Hewett, E. W., and Wareing, P. F. 1973. CYTOKININS IN POPULUS X ROBUSTA: QUALITATIVE CHANGES DURING DEVELOPMENT. Physiologia Plantarum 29 (3): 386-389 [E., 13 ref.]
Total cytokinin activity and diversity were greatest in expanding leaves. The amount and number of cytokinins decreased with age.

161 PHYSIOLOGY

Hewett, E. W., and Wareing, P. F. 1973. CYTOKININS IN POPULUS X ROBUSTA: CHANGES DURING CHILLING AND BUD BURST. Physiologia Plantarum 28 (3): 393-399 [E., 38 ref.]
Amounts of cytokinin were not detectable in Dec. and Jan., but parallel increases occurred in the sap and buds during Feb. and March in both types of material.

Parkhurst, D. F., and Gates, D. M. 1966. TRANSPIRATION RESISTANCE AND ENERGY BUDGET OF POPULUS SARGENTII LEAVES. Nature, Lond. 210 (5032): 172-4. 1 ref.

Vasil'eva, N. P. 1970. [COMPARATIVE CHARACTERISTICS OF THE GROWTH AND CERTAIN ENDOGENOUS GROWTH REGULATORS OF POPULUS SUAVEOLENS OF DIFFERENT GEOGRAPHICAL ORIGIN.] Fiziol. Rast. 17 (6): 1209-16. [Ru.e., 20 refs. A.P.B.]
Gives details of the phenology, height growth, and growth regulators of 11 clones of P. suaveolens from various parts of its natural range (47-68° N. and 109-160° E.) when grown in the Moscow region.

164 MORPHOLOGY

Belostokov, G. P. 1965. [ANATOMICAL STRUCTURE OF THE PERICARP OF CERTAIN WOODY PLANTS.] Nauc. Dokl. Vyss. Skoly (Biol. Nauki) (4), (114-9). 19 refs. [Ru.] N.L.L.

Smith, N. G., and Wareing, P. F. 1972. THE DISTRIBUTION OF LATENT ROOT PRIMORDIA IN STEMS OF POPULUS X ROBUSTA, AND FACTORS AFFECTING THE EMERGENCE OF PREFORMED ROOTS FROM CUTTINGS. Forestry 45 (2): 197-209 [E., 20 ref.]

165 PHYLOGENY, EVOLUTION. HEREDITY, GENETICS AND BREEDING, VARIATION

165.3/.7

Chira, E., and Biflikova, K. 1972. [CONTROL OF POLLEN STERILITY AND STUDY OF THE DEVELOPMENT OF POLLEN WITH MORE THAN THE HAPLOID CHROMOSOME NUMBER IN POPULUS 'ROBUSTA'.] Lesnictvi 18 (6): 551-565. [Sk.ru.e.de.f., 25 ref.]
Pollen sterility was attributed to alternating above- and below-zero temperatures (+ 19.2° C and −4.4° C). For producing viable pollen grains with more than the haploid number of chromosomes, short-term temperatures of +30 to +40° C were best.

Crawford, D. J. 1974. A MORPHOLOGICAL AND CHEMICAL STUDY OF POPULUS ACUMINATA RYDBERG. Brittonia 26 (1): 74-89. [E., 36 ref.]

Jones, A. G., and Seigler, D. S. 1974. POPULATIONAL OBSERVATIONS AND FLAVONOID DATA IN SUPPORT OF HYBRID STATUS FOR POPULUS ACUMINATA RYDBERG. [Abstract]. American Journal of Botany 61 (5, Suppl.): 45. [E., OBD]

165.41

Horgan, R., Hewett, E. W., Purse, J. G., and Wareing, P. R. 1973. A NEW CYTOKININ FROM POPULUS ROBUSTA. Tetrahedron Lett 30: 2827-2828.

165.52/53

Vasil'eva, N. P. 1971. [SOME ENDOGENOUS GROWTH REGULATORS IN POPLARS.] Lesoved. (3), (49-59). [Ru.e., 31 refs.]

168 HISTOLOGY

Belostokov, G. P. 1966. [STRUCTURE OF THE CONDUCTING SYSTEM OF SEEDLINGS OF BROADLEAVED SPECIES WITH EPIGEAL GERMINATION.] Bot. Z. 51 (5): 705-16. [41 refs. [Ru.].]

17 SYSTEMATIC BOTANY

176.1 DICOTYLEDONEAE

Broekhuizen, J. T. M. 1964. [THE PROBLEM OF 'ZEELAND'.] Populier, Wageningen 1 (1): 6-7. [Du.]

Rohmeder, E. 1965. [POPULUS 'BACHELIERI' AND POPULUS 'VERNIRUBENS' DON'T EXIST.] Repr. from Deutsche Baumschule, Aachen (7), (190-5). [11 refs. [G.g.].]
Draws attention to the work of R. Muller in unravelling the confusion in the naming of the hybrid Black Poplars.

Steenackers, V. 1964. [THE CLONES OF POPULUS X ROBUSTA.] Populier, Wageningen 1 (3): 5-6. [Du.]
Compares Belgian data on taxonomic features, resistance to disease, and growth rates of 'Robusta' (Belgian 'Red Robusta') and 'Zeeland' ('Green Robusta').

18 PLANT ECOLOGY

181 MODE OF LIFE, AUTECOLOGY. SILVICULTURAL CHARACTERS OF TREES

181.2

Pieters, G. A. 1974. [THE GROWTH OF SUN AND SHADE LEAVES OF POPULUS EURAMERICANA "ROBUSTA" IN RELATION TO AGE, LIGHT INTENSITY AND TEMPERATURE.] Wageningen, Veenman and Zonen, 107 p. illus.

181.31

Braun, H. J. 1971. [A METHOD FOR STUDYING THE WATER CONSUMPTION OF WOODY PLANTS. II. RESULTS OF EXPLORATORY TESTS.] Forstwiss. Cbl. 90 (5): 319-28. [De.e., 2 ref.]

Braun, H. J. 1973. [TREES AND THEIR ENVIRONMENT.] Allgemeine Forst- und Jagdzeitung 144 (3): 60-62 [De.e.f., 4 ref.]

Braun, H. J., and Schmidt, P. 1973. [THE PRODUCTIVITY OF WATER CONSUMPTION BY TREES.] Zeitschrift fur Pflanzenphysiologie 70 (3): 270-275 [De.e., 6 ref. OBD]

Miroshnichenko, Yu. M. 1972. [THE AMOUNT OF WATER IN LEAVES OF DESERT-STEPPE AND INTRODUCED PLANTS IN THE GOBI, MONGOLIA.] Ekologiya (1), (37-44). [Ru., 6 ref. NLL]

181.32/.34

Garbaye, J. 1974. [AN EXAMPLE OF LIMITING ECOLOGICAL CONDITIONS FOR POPULUS 'ROBUSTA': THE OLD PLANTATIONS AWAY FROM VALLEYS ON CLAYEY SOILS IN LORRAINE.] Revue Forestiere Francaise 26 (4): 289-293 [F.]

Pantos, D. T. 1972. [STUDY OF THE GROWTH AND NUTRIENT UPTAKE OF POPULUS 'ROBUSTA' GROWN FROM CUTTINGS.] Erdeszeti es Faipari Egyetem Tudomanyos Kozlemenyei No. 1/2, 23-37 [Hu.ru.e.de., 7 ref.]
Results showed that a rich supply of nutrients, especially NP, in the first 2-4 months is critical for the development of roots and for survival. Shoot growth remains slow until a dense root system has developed, despite rapid uptake of nutrients.

Rahteenko, I. N., and Kocanovskij, S. B. 1965. [VITALITY OF ROOT SYSTEMS OF WOODY PLANTS IN RELATION TO AERATION CONDITIONS.] Fiziol. Rast. 12 (4): 597-605. 9 refs. [Ru.ru.e.] A.P.B.

Smilde, K. W. 1973. PHOSPHOROUS AND MICRONUTRIENT METAL UPTAKE BY SOME TREE SPECIES AS AFFECTED BY PHOSPHATE AND LIME APPLIED TO AN ACID SANDY SOIL. Plant and Soil 39 (1): 131-148 [E., 27 ref.]
It is concluded that internal plant tolerance is more important than exclusion mechanisms in neutralizing the effects of toxic concentrations of Zn and possibly Fe in the soil.

Stoneman, D. L. 1967. SOIL – COTTONWOOD RELATIONSHIPS IN SHELTERBELTS OF THE CENTRAL PLATTE RIVER VALLEY IN NEBRASKA. Abstr. of thesis, in Dissert. Abstr. 28B (2): 433-4. [O.R.S.]

181.36

Hallik, J. 1973. [DEVELOPMENT OF THE ROOT SYSTEM OF PLANTATIONS ON LEVELLED OIL-SHALE WORKINGS.] Metsanduslikud Uurimused 10, 186-199 [Ee.ru.e., 10 ref.]
Some data are given on the root systems in one plantation of Populus suaveolens.

181.5

Necaev, A. P. 1967. [REGENERATION OF SALICACEAE BY SEED ON THE PEBBLE BEDS OF THE BUREYA RIVER [SOVIET FAR EAST].] Lesoved., Moskva (1), (54-63). [27 refs. [Ru.e.].]
Successful regeneration was observed only when the time of seed dispersal coincided with a low water level.

187 VEGETATION TYPES

Gesink, R. W., Tomanek, G. W., and Hulett, G. K. 1970. A DESCRIPTIVE SURVEY OF WOODY PHREATOPHYTES ALONG THE ARKANSAS RIVER IN KANSAS. Transactions of the Kansas Academy of Science 73 (1): 55-69 [E., 19 ref. NLL]

Lindauer, I. E. 1967. ECOLOGY OF PHREATOPHYTES ON THE ARKANSAS RIVER IN SOUTHEASTERN COLORADO. Abstr. in Journal of the Colorado-Wyoming Academy of Sciences, Fort Collins 5 (8), (65). [N.L.L.]

Saga, V. S. 1966. [THE MAIN ASSOCIATIONS OF THE POPLAR FORESTS OF THE BUREYA FLOODPLAIN.] Lesn. Z., Arhangel'sk 9 (1): 47-50. [Ru.]
Gives notes on the composition, mensurational data, etc. of 10 types of Poplar associations (mostly pure Populus suaveolens) in this part of the Soviet Far East.

2 SILVICULTURE

23 REGENERATION AND FORMATION OF STANDS

232 ARTIFICIAL REGENERATION

232.13

Werner, H., and Dagenbach, H. 1965. [THE GROWTH OF POPULUS 'ROCHESTER' IN SHADED STREAM-VALLEYS.] Mitt. Ver. Forstl. Standortskunde Forspfl Zucht. No. 15, (56-64). 5 refs. [G.e.]

232.323

Sun, S. H. 1964. [A STUDY OF THE AMOUNT OF SEED AND THE WIDTH OF SOWING IN STRIPS FOR POPULUS SIMONII.] Sci. Silvae, Peking 9 (3): 246-52. [19 refs. [Chin.] N.L.L.]
A formula is given from which the required seed weight for a given area is derived for the range of sowing densities recommended, taking into account purity, weight and germinative capacity.

232.325

Papp, L. 1968. [SHOOT PRUNING OF LARGE POPLAR PLANTING STOCK.] Hung. For. sci. Rev. (122-30). [G.]
A study of Populus X robusta.

232.328

Mgaloblishvili, S. V. 1972. [[PROPAGATION OF] POPULUS RUBRINERVA [BY CUTTINGS.].] Subtropicheskie Kul'tury No. 4 (142-144). [Ru.]

Smith, N. G., and Wareing, P. F. 1971. THE EFFECT OF GRAVITY ON ROOT EMERGENCE FROM CUTTINGS OF SOME TREE SPECIES. Forestry 44 (2): 177-187. [18 ref.]

Smith, N. G., and Wareing, P. F. 1972. THE ROOTING OF ACTIVELY GROWING AND DORMANT LEAFY CUTTINGS IN RELATION TO ENDOGENOUS HORMONE LEVELS AND PHOTOPERIOD. New Phytologist 71 (3): 483-500 + 1 pl. [E., 44 ref. OBD]
Under a long-day regime, the rooting ability of the cuttings declined during the summer until mid-Aug. This was correlated with a decline in content of an auxin having the R_F of IAA.

Smith, N. G., and Wareing, P. F. 1972. ROOTING OF HARDWOOD CUTTINGS IN RELATION TO BUD DORMANCY AND THE AUXIN CONTENT OF EXCISED STEMS. New Phytologist 71 (1): 63-80 + 1 pl. [E., 34 ref. OBD]

232.41

Marcet, E. 1973. [PLANTING POPLARS WITHOUT BRANCHES.] Schweizerische Zeitschrift fur Forstwesen 124 (2): 92-104 + 6 photos. [De.f., 5 ref.]
In a comparative study with 1 + 2 rooted Populus 'Robusta', removal of all branches immediately after planting improved height and diameter growth in the first growing season. Crown development as regards number and size of branches and quantity of foliage was also superior.

232.42

Pantos, G., and Pantos, D. T. 1971. [THE INFLUENCE OF FERTILIZING ON THE GROWTH OF POPULUS 'ROBUSTA'.] Erdeszeti es Faipari Egyetem Tudomanyos Kozlemenyei No. 1/2, 5-21 [Hu.ru.e.de., 7 ref.]
The most effective fertilizer combination was NP (200 kg/ha each of NH_4NO_3 and superphosphate).

232.43

Szodfridt, I. 1972. [COMPREHENSIVE EVALUATION OF SPACING EXPERIMENTS WITH POPULUS 'SEROTINA' AT TOLNASZIGET.] Kiserletugyi Kozlemenyek Erdogazdasag es Faipar, D 63 (1/3): 29-46. [Hu.] From Hungarian Agricultural Review 22, 698. CGB.
The main conclusions are that: height is not influenced by spacing; mean diameter increases, but growing stock decreases, with wider spacing.

233 AFFORESTATION

Harabin, Z., and Klein, T. 1973. [GROWTH AND DEVELOPMENT OF TREES ON A SLAG HEAP.] Sylwan 117 (1): 63-69. [Pol.ru.e., 1 ref.]
After 7 growing seasons, Populus 'Serotina' has the best height growth, followed by Robinia pseudoacacia and then Alnus glutinosa.

237 AMELIORATION OF FOREST SITES

Spirchez, Z. 1974. [THE APPLICATION OF NITROGENOUS FERTILIZERS IN FOREST PLANTATIONS ON THE SANDS OF NW RUMANIA.] Revista Padurilor – Industria Lemnului, Silvicultura si Exploatarea Padurilor 89 (1): 17-20 [Ro.]
The largest % increases in yield relative to controls were obtained in the first 7 years or so, and an important advantage is the economy resulting from more rapid canopy closure.

26 COMBINATIONS OF FORESTRY WITH AGRICULTURE

265 STRIPS OR LINES AT ROAD, RAIL AND CANAL SIDES, ETC.; HEDGEROW TREES

Jovkovic, B., and Curic, R. 1974. [CULTIVATION OF POPLAR IN HILLY AND MOUNTAINOUS COUNTRY.] Topola 18 (100/101): 81-82. [Sh.e.]

3 WORK SCIENCE. HARVESTING OF WOOD: LOGGING AND TRANSPORT. FOREST ENGINEERING

Pagony, H. 1973. [THE IMPORTANCE FOR FORESTRY OF THE CONTROLLED DECAYING OF STUMPS.] Erdo 22 (9): 407-409. [Hu.ru.e.]
Describes trials in Hungary of stump inoculation with Pleurotus ostreatus. Stumps of Populus 'Robusta' inoculated in the spring produced fruiting bodies the same autumn and were easily cut with a knife in the second year; heavier hardwoods decayed more slowly.

Szecska, D. 1972. [HYDRAULIC SHEARS FOR THE CLEANING OF YOUNG CONIFER STANDS.] Erdo 21 (5): 232-234. [Hu.ru.e.]

4 FOREST INJURIES AND PROTECTION

42 INJURIES FROM INORGANIC AGENCIES (EXCLUDING FIRE)

422 TEMPERATURE INFLUENCES. INSOLATION

Keresztesi, B., and Pagony, H. 1973. [DAMAGE CAUSED BY EARLY FROST IN MIXTURES OF ROBINIA PSEUDOACACIA WITH POPLARS.] Erdo 22 (8): 366-371 [Hu.ru.e.]
Tissues round the buds and lateral shoots were most severely damaged in both species, forming cankers encircling the shoot bases. Clear felling is recommended, with regeneration to Robinia coppice.

Marcu, G., Papadopol, C. S., and Pirvu, E. 1970. [STUDIES ON THE RESISTANCE TO FLOODING OF PLANTATIONS OF POPULUS 'ROBUSTA, HIRSOVA, CLONE R-16', IN THE FIRST YEAR AFTER PLANTING.] Stud. Cerc. Inst. Cerc. Silvice 27 (2): 371-82. [Ro.f.de., 10 ref.]
There was a significant positive correlation between damage and duration of flooding. The number of severely damaged plants reached 50% after 75 days' flooding; 10% had died during 90 days of flooding, and all were dead after 130 days.

44 DAMAGE BY HARMFUL PLANTS. VIRUS DISEASES

443.6 FUNGI AND BACTERIA

Mocanu, V., and Tanase, I. 1968. [THE DYNAMICS OF NUCLEIC AND AMINO ACIDS IN THE BARK OF POPLARS (POPULUS 'ROBUSTA R_{20}') ATTACKED BY DOTHICHIZA POPULEA.] Phytopath. Z. 63 (3): 267-71. [9 refs. [F.f.g.e.] O.R.S.]
There was a marked reduction in free and bound amino acids in bark infected with both D. populea and Cytospora sp.

Ride, M. 1964. [THE RISK OF A RECRUDESCENCE OF BACTERIAL CANKER OF POPLAR.] Rev. for. franc. 16 (4): 302-5. [F.]

Tanase, I., and Mocanu, V. 1968. [BIOCHEMICAL MODIFICATIONS INDUCED IN POPULUS (P. 'ROBUSTA R_{16}') BY DOTHICHIZA POPULEA.] Phytopath. Z. 63 (3): 259-66. [14 refs [F.f.g.e.] O.R.S.]

Veldeman, R. 1971. 'CHALAROPSIS SP.', A NEW PARASITIC FUNGUS ON POPLAR, THE CAUSE OF BARK LESIONS. Meded. Fac. Landbouw. Gent 36 (3): 1001-5. [E.. CGB]
It is concluded that C. populi is the causal agent of the bark necrosis of Poplars known as 'trunk scab disease', 'Braunfleckengrind', etc., and is a typical cambium killer.

45 DAMAGE BY ANIMALS

453 INSECTS

Luitjes, J. 1973. [THE EFFECT OF DEFOLIATION BY LEUCOMA SALICIS ON THE GROWTH OF POPLAR.] Nederlands Bosbouw Tijdschrift 45 (2): 45-53. [Nl.e.]

Nef, L. 1971. [INFLUENCE OF CHEMICAL AND MICROBIAL INSECTICIDES ON A POPULATION OF STILPNOTIA (LEUCOMA) SALICIS AND ITS PARASITES.] Z. angew. Ent. 69 (4): 357-67. [F.de., 16 ref. OH]
DDT caused immediate massive mortality but greatly reduced the parasite population. Bacillus thuringiensis was nearly as effective as DDT and killed relatively few parasites. Virus (Borrelinavirus sp.) had little immediate effect on the pest or parasites but significantly reduced the weight and fecundity of adult ♀s and the viability of the eggs; its ecological effect may therefore be long-lasting.

Pascovici, V. 1973. [CLOSTERA (PYGAERA) ANASTOMOSIS, A SERIOUS DEFOLIATOR OF UNTHRIFTY PURE POPLAR PLANTATIONS.] Revista Padurilor 88 (6): 308-311. [Ro., 7 ref.]
Reports P. anastomosis as the cause of 100% defoliation of 200 ha of 8-year-old Populus 'Robusta R-18' (P. 'Hirsova') near Iasi, Rumania, in 1972.

5 FOREST MENSURATION

56 INCREMENT; DEVELOPMENT AND STRUCTURE OF STANDS

Halupa, L. 1969. [THE GROWTH PATTERN OF POPULUS 'ROBUSTA' ON THE ACID SANDY SOILS OF HUNGARY.] Erdesz. Kutatas. 65 (1): 65-70. [G., 4 refs.]

Halupa, L. 1973. [THE COURSE OF GROWTH OF POPULUS 'ROBUSTA' IN THE NYIRSEG REGION [OF HUNGARY].] Erdesz. Kutatas., Budapest 63 (1/3): 81-94. [15 refs. [Hu,hu,ru.g.].]
Stem analyses in 37 stands aged ⟩ 20 years indicated that height and diameter growth culminated between 3 and 5 years, declining first rapidly to 10-13 years, and thereafter slowly (height) or not at all (diam.).

Lemoine, B. 1969. [SOME PLANTATIONS OF POPULUS 'ROBUSTA' IN THE GARONNE VALLEY.] Rev. for. franc. 21 (6): 568-70. [F., 1 ref.]

Ratzel, K. 1969. [YIELD OF POPULUS 'ROBUSTA' IN PURE CLOSED STANDS.] Allg. Forst- u. Jagdztg. 140 (11): 239-50. [G.e.f., 13 refs.]

Ratzel, K. 1971. ERTRAGSTAFEL FUR DIE ROBUSTA-PAPPEL IM GESCHLOSSENEN REINBESTAND. Holzzucht, Reinbek 25 (1): 4-6. [1 graph. Darst., 2 Tab., 1 Lit. Ang.]

Szodfridt, I. 1969. [YIELD OF POPULUS 'ROBUSTA' STANDS IN HUNGARY.] Erdesz. Kutatas. 65 (1): 103-8. [G.]
Discusses (with extracts) a new yield table based on 200 plots in various parts of Hungary.

8 FOREST PRODUCTS AND THEIR UTILIZATION

81 WOOD AND BARK: STRUCTURE AND PROPERTIES

811 STRUCTURE. IDENTIFICATION

Anonymous. 1968. [ANATOMICAL RESEARCH ON DIMENSIONS OF LIBRIFORM FIBRES IN BRANCHWOOD OF A 'ROBUSTA' POPLAR.] Report H 68-143 Houtinstituut TNO (Forest Products Research Institute TNO), Delft. [Du.]

811.1

Suss, H., and Muller-Stoll, W. R. 1970. [CHANGES IN CELL DIMENSIONS AND IN PERCENTAGE OF WOOD ELEMENTS IN DIFFUSE-POROUS WOODS WITHIN ONE GROWTH PERIOD.] Holz Roh- u. Werkstoff 28 (8): 309-17. [G.e., 17 refs. P.R.]
The size of cells and distribution of wood elements exhibit regular variations within one growth ring, but the pattern differs between different woods.

811.2

Ueda, K. 1973. [STUDIES ON THE MECHANICAL PROPERTIES OF REACTION WOODS. REPORT 2. THE ELASTIC CONSTANTS OF ICHO (GINKGO BILOBA L.), YAMANARASHI (POPULUS SIEBOLDII MIQ.) AND YACHIDAMO (FRAXINUS

MANDSHURICA VAR. JAPONICA MAXIM.).] Bulletin of the College Experiment Forests, Hokkaido University 30 (2): 379-388. [Eng. 3 ref.]

812 PHYSICAL AND MECHANICAL PROPERTIES

Siek, M. 1972. [SOME PHYSICAL AND MECHANICAL PROPERTIES OF POPLAR WOOD.] Sylwan 116 (3): 43-46 + 4 tab., 1 fig. [Pol.ru.e., 6 ref.]
Gives tabulated and graphical data, indicating that the properties of wood of Populus 'Serotina' trees 18 and 27 years old grown in Poland did not differ significantly.

813 WOOD CHEMISTRY

Milishkevich, Ya. G., and Reznikov, V. M. 1972. [INVESTIGATION OF THE LIGNIN OF POPULUS 'ROBUSTA'.] Khimiya Drevesiny No. 12, 17-20. [Ru., 14 ref. NLL]
Gives results of a study of the composition of milled wood lignin obtained from a 30-year-old tree.

814 NATURAL DURABILITY. OLD WOOD. FOSSILIZED WOOD

Hedley, M. E., and Foster, J. B. 1972. MODIFIED SOIL/BLOCK TECHNIQUE FOR ASSESSING WOOD DECAY. New Zealand Journal of Forestry Science 2 (2): 237-248 [E., 11 ref.]

815 EFFECT OF GROWTH FACTORS ON STRUCTURE AND PROPERTIES

Sachsse, H. 1974. [OCCURRENCE AND SPATIAL DISTRIBUTION OF 'DIRECTIONAL TISSUE' IN THE ROOTWOOD OF POPULUS 'ROBUSTA'.] Holz als Roh- und Werkstoff 32 (7): 263-269 [De.e., 12 ref. PR]
Roots of three young Poplar trees that were subjected to an upward bending stress developed on the upper half of the cross-section 'directional tissue' ['d.t.'] in a manner analogous to the production of tension wood in shoots above the ground.

83 TIMBER MANUFACTURING INDUSTRIES AND PRODUCTS

Anonymous. 1966. [INVESTIGATION INTO THE PROCESSING OF POPULUS 'ROBUSTA' WOOD IN A MATCH FACTORY AND IN A SAWMILL.] Report H 66-140 Houtinstituut TNO (Forest Products Research Institute TNO), Delft. [Du.]

Anonymous. 1968. [INVESTIGATIONS ON THE UTILIZATION OF POPULUS 'ROBUSTA' WOOD IN A MATCH FACTORY AND IN A SAWING MILL.] Report H 68-174 Houtinstituut TNO (Forest Products Research Institute TNO), Delft. [Du.]

84 PRESERVATION AND OTHER TREATMENTS TO IMPROVE THE PROPERTIES OF WOOD. DAMAGING INFLUENCES

Koberle, M., and Durisova, V. 1972. [CONTACT DRYING OF POPLAR [POPULUS 'ROBUSTA'] SAWN TIMBER.] Drevarsky Vyskum 17 (2): 47-62. [Sk.ru.de.e., 4 ref.]

86 PULP INDUSTRIES

861 PULP AND PAPER MANUFACTURE. TEXTILE AND OTHER CELLULOSE DERIVATIVES

Diaconescu, V., and Riscuta, S. 1972. [EXTRACTION OF POPLAR HEMICELLULOSE IN SEVERAL STAGES.] Celuloza si Hirtie 21 (2): 101-109 [Ro., 13 ref.] From Cellulosa e Carta 24 (5): 72 [It.]
Gives results of a study of the chemical composition of hemicellulose derived from the sapwood of 5-year-old Populus 'Robusta' trees grown in Rumania.

Rutkowski, J., and Mroz, W. 1972. [THE BLEACHING OF SULPHATE PULPS MADE FROM POPLAR WOOD AND FROM MIXTURES OF CHIPS OF POPLAR AND PINE WOOD.] Przeglad Papierniczy 28 (9): 291-296. [Pol., 14 ref.] From Cellulosa e Carta 24 (11): 50. [It.]
The study showed that sulphate pulps made from Populus 'Robusta' wood could be bleached satisfactorily, required less bleach than pulps made from Pine [Pinus sylvestris], and produced pulp characterized by a higher yield and greater opacity than Pine pulp and not noticeably inferior in strength.

Rutkowski, J., and Mroz, W. 1972. [THE PREPARATION OF EASILY BLEACHABLE SULPHATE PULP FROM POPLAR WOOD AND MIXTURES OF POPLAR AND PINE WOOD.] Przeglad Papierniczy 28 (7): 209-214. [Pol., 15 ref.] From Cellulosa e Carta 24 (10): 61. [It.]
Gives data on the yield, K number and strength properties of Populus 'Robusta' sulphate pulps, which proved easy to bleach, and on the characteristics of sulphate pulps made from a mixture of Poplar and Pine [Pinus sylvestris].

Tocan, M., Cretu, L., and Popa, V. 1970. [MODIFICATIONS IN THE STRUCTURE OF NORMAL AND TENSION WOOD OF POPLAR DURING THE DELIGNIFICATION PROCESS.] Celuloza si Hirtie 19 (12): 415-421 + smries. [Ro.f.e.de.ru., 5 ref. NLL]
Marked differences were observed in the behaviour of normal and tension wood during delignification with sulphate liquor but not with $NaClO_2$.

861.1

Rutkovski, I. A. 1973. [STUDY ON THE BLEACHABLE SULPHITE PULPS PREPARATION OUT OF POPULUS ROBUSTA WOOD.] Cellul. Chem. Technol. 7 (2): 243-253. Ref. [Ru.e.]

P. TREMULA

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

11 SITE FACTORS: CLIMATE, SITUATION, SOIL, HYDROLOGY

111 THE ATMOSPHERE. METEOROLOGY. CLIMATE AND MICROCLIMATE

111.2

Akulova, E. A., et al. 1964. [LIGHT TRANSMISSION THROUGH A FOREST CANOPY IN RELATION TO INCIDENT RADIATION AND TREE-CROWN DENSITY.] Fiziol. Rast. 11 (5): 818-23. 29 refs. [Ru.e.] A.P.B.
Species studied were Acer platanoides, Corylus avellana, Tilia cordata, Populus tremula, Salix sp. and Pinus sylvestris.

Tsel'niker, Yu. L., and Khazanov, V. S. 1971. [OPTICAL PROPERTIES OF SUN AND SHADE LEAVES AND OF THEIR COMPONENTS.] Lesoved. (2), (7-14). [Ru.e., 16 ref.]
It is concluded that light energy is more uniformly distributed through the middle and lower tissue layers of shade leaves, accounting for their more efficient photosynthetic utilization of light of low intensity.

111.8

Alekseev, V. A. 1969. [THE MICROCLIMATE IN ASPEN STANDS.] Lesn. Z., Arhangel'sk 12 (4): 7-10. [Ru., 9 refs.]

Lositskii, K. B. 1974. [EVALUATION OF CLIMATE FROM THE POINT OF VIEW OF PRODUCTION IN FORESTRY.] Lesnoe

Khozyaistvo No. 7, 34-37 [Ru.]
Compares the productivity of Norway Spruce stands (in m^3/ha at age 100 years) in various subzones of the taiga and mixed-forest zones in the USSR, with the radiation balance (in kcal/cm^2/year) and the sum of active temperatures (above +10° C) in each zone.

114 SOIL. SOIL SCIENCE

Demidenko, V. P., and Gadzhiev, I. M. 1972. [THE EFFECT OF SOIL CONDITIONS ON THE DISTRIBUTION AND PRODUCTIVITY OF POPULUS TREMULA FORESTS OF THE MIDDLE OB'REGION.] Tr. Biol. Inst. Akad. Nauk. SSSR Sibirsk. Otd. 15: 59-71. [Ru.]

114.2

Curtin, G. C., et al. 1968. UTILIZATION OF HUMUS-RICH FOREST SOIL (MULL) IN GEOCHEMICAL EXPLORATION FOR GOLD. Circular, United States Geological Survey No. 562, pp. 11. [From abstr. in Soils & Fertil. 1969, 32 (1): No. 517.]
Concentration of Au in Pine and Aspen mulls was more representative of Au deposits in bedrock beneath colluvial and glacial cover than was the concentration in pebbles, cobbles and soil below the mull.

Kutuzova, R. S. 1968. [THE TRANSFORMATION OF THE SILICA OF PLANT RESIDUES IN THE PROCESS OF MINERALIZATION.] Pocvoved. (7), (119-28). [17 refs. [Ru.e.] N.L.L.]
Describes laboratory investigations to ascertain the microscopical structure of SiO_2 in decomposing foliage of Spruce, Birch, Aspen and fern, and also the changes in its SiO_2 content.

Volkova, M. J., Mahonina, G. I., and Titljanova, A. A. 1964. [EFFECT OF NATURAL [LEAF] EXTRACTS ON THE SORPTION OF CERTAIN RADIO-ISOTOPES BY THE SOIL.] Pocvoved. (3), (52-7). 20 refs. [Ru.e.] A.P.B.
A laboratory study was made of the desorption of Rb^{86}, Ru^{106}, Ag^{110}, Cd^{115}, Ce^{144}, Sr^{90} and Y^{90}, in two types of soil, by aqueous extracts from yellow leaves of Aspen, Prunus padus, Birch, fern, and Pine. The mobility of all these elements was increased by the extracts, apparently owing to the formation of soluble complex compounds with the organic matter of the extracts.

114.3

Donov, V. 1964. [AMOUNTS OF LITTER IN BEECH, ASPEN AND HORNBEAM STANDS.] Nauc. Trud. Lesoteh. Inst., Sofija 12, (33-40). 10 refs. [Bulg.g.]

114.4

Cekalova, M. I. 1965. [CHARACTERISTICS OF THE DARK SOILS OF THE FOREST ZONE [OF THE U.S.S.R.].] Pocvoved. (2), (25-32). 15 refs. [Ru.e.] A.P.B.
Describes the chemical and physical characteristics of dark soils with excess surface moisture under (a) Birch/Pine, (b) Birch/Aspen, and (c) an old ley, in the Leningrad region.

Cernov, V. P. 1965. [TYPICAL PODZOLIC SOILS OF THE PERM REGION FORMED ON UNTRANSPORTED AND MORAINE CLAY-LOAMS.] Pocvoved. (3), (1-12). 7 refs. [Ru.e.] A.P.B.

114.6

Aleksakhina, T. I. 1972. [SOIL ALGAE IN THE RHIZOSPHERE OF THE MAIN PLANT SPECIES IN FOREST BIOGEOCOENOSES.] Ekologiya (1), (45-52). [Ru., 24 ref. NLL]

Egorova, S. V. 1970. [EFFECT OF FELLING ASPEN ON THE MICROFLORA OF A DARK-GREY FOREST SOIL.] In Vzaimootnosenija Komponentov Biogeocenoza v Listvennyh Molodnjakah. Izdatel'stvo 'Nauka', Moscow. pp. 149-51. [Ru., 7 refs.]
Within the stands themselves, populations of the soil microflora were highest at ages 32 and 45, but clear felling activated the microbiological processes in the soil by increasing the populations of bacteria and actinomycetes. Clear felling did not significantly affect the population of microscopic fungi.

15 ANIMAL ECOLOGY

Bobek, B., Weiner, J., and Zielinski, H. 1972. FOOD SUPPLY AND ITS CONSUMPTION BY DEER IN A DECIDUOUS FOREST OF SOUTHERN POLAND. Acta Theriologica 17, 187-202 [E.] From Berichte Biochemie und Biologie (1973) 379, 1901. De. Reinbek.
Sample counts of shoots of woody species browsed compared with shoot production in fenced areas indicated that 8,4% of the available food was used over the year, but that the % was much higher in winter and would reach 26% in the youngest plantations. Up to 81% of the annual growth of Populus tremula, the preferred food, was taken.

Padajga, V. I. 1970. [EFFECT OF INTENSIVE FELLING OF ASPEN ON THE REDUCTION OF DAMAGE BY ROE-DEER.] Lesoved. (6), (94-6). [Ru.e., 4 refs.]
It is concluded that the felling of Aspen will help to reduce damage only in areas where the roe populations are maintained at tolerable densities.

16 GENERAL BOTANY

160 PLANT CHEMISTRY

Ahrens, E. 1964. [THE CONTENT OF Cu, Zn, B, Mo AND Mn IN FOLIAGE OF VARIOUS TREE SPECIES.] Allg. Forst- u. Jagdtzg. 135 (1): 8-16. 10 refs. [G.g.e.]

Barna, M. M. 1971. [LOCALIZATION OF POLYSACCHARIDES IN TISSUES OF THE REPRODUCTIVE ORGANS IN SOME POPLAR SPECIES.] Ukr. bot. Zh. 28 (4): 487-93. [Uk.e., 19 ref. APB]
Describes studies on the change in the location and quantity of polysaccharides in the various tissues during inflorescence development and seed formation in diploid and triploid Populus tremula and P. nigra var. italica.

Munteanu, C., and Kalo, M. 1971. [SOME BIOCHEMICAL ASPECTS OF METABOLISM IN VISCUM ALBUM L. AND IN ITS HOST POPULUS TREMULA L.; AMOUNT OF TOTAL AND REDUCING SUGAR.] Cluj. Univ. Babes-bolyai Stud. Ser. Biol. 16 (1): 79-84. Ref. [Ru.e.]

Olsen, R. A., Odham, G., and Lindeberg, G. 1971. AROMATIC SUBSTANCES IN LEAVES OF POPULUS TREM AS INHIBITORS OF MYCORRHIZAL FUNGI. Physiol. Plant. 25 (1): 122-9. [11 ref.]

Smirnov, V. V., and Semenova, V. G. 1972. [SEASONAL CHANGES IN THE CONTENTS OF THE ASH ELEMENTS IN LEAVES OF BIRCH AND ASPEN.] Ekologiya No. 2, 91-92 [Ru., 9 ref. NLL]
The data do not support the idea of a general outflow of mineral substances from the leaves in the period before leaf fall.

Turunen, J., and Visapaa, A. 1973. SULPHUR IN SPRUCE NEEDLES AND ASPEN LEAVES. PART III. DETERMINATION OF THE SULPHUR CONTENT BY X-RAY FLUORESCENCE. Paperi ja Puu 55 (2): 69-70. [E.fi., 2 ref.]
The X-ray fluorescence method used for determining the amount of S in foliage of Pine and Birch is here extended to Spruce and Aspen. The results of statistical tests are given.

161 PHYSIOLOGY

Antipov, N. I. 1971. [THE CORRELATION BETWEEN CUTICULAR AND STOMATAL TRANSPIRATION IN TREES AND SHRUBS.] Fiziol. Rast. 18 (6): 1207-12. [Ru.e., 32 ref. NLL]

Antipov, N. I. 1971. [CORRELATION BETWEEN CUTICULAR AND STOMATAL TRANSPIRATION IN WOODY AND BUSHY PLANTS.] Soviet Plant Physiol. 18 (6): 1026-1030. Ref.

Belov, S. V. 1964. [ASSESSING THE HYGIENIC ROLE OF FOREST.] Lesn. Hoz. 17 (1): 8-13. [Ru.]
These computations show that measures to increase the rate of wood increment in green-belt forests will also improve the hygienic role of the forests. On smaller areas (e.g. in park stands) the aesthetic value is of more importance than production of timber or O_2.

Carev, A. P. 1969. [SEXUAL DIMORPHISM OF ASPEN.] Lesoved., Moskva (2), (76-8). [13 refs. Ru.e.].]
The ♂ trees occupied the drier and less fertile areas, and generally had straighter stems, bigger branches, and wider crowns, and greater diameter and height than the ♀ trees.

Ekberg, I., et al. 1967. THE MEIOTIC DEVELOPMENT IN MALE ASPEN. Studia for. suec. Skogshogsk., Stockh. No. 58, pp. 16. [26 refs. [E.e.sw.].]
At temperatures of 19-25° C. (day) and 15-18° (night), development from pachytene (the longest-lasting stage) to microspores took ca. 30 hr. Various stages were often found simultaneously in individual flowers.

Eliasson, L. 1969. GROWTH REGULATORS IN POPULUS TREMULA, I. DISTRIBUTION OF AUXIN AND GROWTH INHIBITORS. Physiol. Plant., Copenhagen 22 (6): 1288-1301. [48 refs.]
A growth promoter, tentatively identified as indol-3-yl-acetic acid, was found in highest concentrations in growing stem parts, and was also present in the roots. Large amounts of inhibitors (inhibitor β) were present in growing stem tissue and in upper mature stem parts. Considerably lower contents of inhibitors were found in leaves, in the basal stem part and the roots.

Eliasson, L. 1971. ADVERSE EFFECT OF SHOOT GROWTH ON ROOT GROWTH IN ROOTED CUTTINGS OF ASPEN. Physiol. Plant. 25 (2): 268-72. [E., 12 ref.]
In rooted cuttings of Populus tremula with a small leaf area, roots grew well in the absence of shoot growth. The onset of shoot growth was followed by a period of decreased root growth, until a sufficient area of leaf tissue had been produced.

Eliasson, L. 1971. GROWTH REGULATORS IN POPULUS TREMULA. II. EFFECT OF LIGHT ON INHIBITOR CONTENT IN ROOT SUCKERS. Physiol. Plant. 24 (2): 205-8. [29 ref.]
Shoots grown from Aspen root sections in light or darkness were examined for growth-regulator contents. The β fraction was ca, 10 times more active in the light-grown than in the dark-grown shoots.

Eliasson, L. 1971. GROWTH REGULATORS IN POPULUS TREMULA. III. VARIATION OF AUXIN AND INHIBITOR LEVEL IN ROOTS IN RELATION TO ROOT SUCKER FORMATION. Physiol. Plant. 25 (1): 118-21. [27 ref.]
Growth substances were present from May to Oct., and were at their highest concentration during the period of shoot growth, though the capacity of root segments to form suckers during this period was low.

Eliasson, L. 1971. GROWTH REGULATORS IN POPULUS TREMULA. IV. APICAL DOMINANCE AND SUCKERING IN YOUNG PLANTS. Physiol. Plant. 25 (2): 263-7. [E., 25 ref.]
Experiments with small, rooted cuttings of P. tremula, grown in culture, showed that auxins transported in a polar direction are important for controlling the growth of axillary buds. When the supply of auxin from the growing apex is cut off, the number of axillary buds breaking dormancy depends on factors in the transpiration stream from the roots.

Eliasson, L. 1972. TRANSLOCATION OF SHOOT-APPLIED INDOLYLACETIC ACID INTO THE ROOTS OF POPULUS TREMULA. Physiologia Plantarum 27 (3): 412-416 [E., 27 ref.]
The application of 10 to 100 µg of IAA to the leaves of rooted cuttings of P. tremula, or to the cut stem surface above the mature leaves, caused an inhibition of root growth after three hours and swelling of the root-tips. Root growth was resumed within 24 hours after the treatment.

Engelbrecht, L. 1971. CYTOKININS IN BUDS AND LEAVES DURING GROWTH, MATURITY AND AGING (WITH A COMPARISON OF TWO BIO-ASSAYS). Biochem. Physiol. Pflanzen 162 (6): 547-58. [E., 24 ref. OBD]

Fedorov, N. I., and Raptunovic, E. S. 1969. [RESPIRATION RATE AND ACTIVITY OF OXIDIZING ENZYMES IN MALE AND FEMALE ASPEN.] Lesoved., Moskva (2), (59-64). [22 refs. [Ru.e.].]
Respiration rate and activity of oxidizing enzymes fluctuated considerably during the growing season. The activity of the oxidizing enzymes (especially polyphenoloxidase) was greater in the sapwood of ♀ Aspen than in ♂, and this may be one of the reasons why ♀ trees are more resistant to heart rot.

Fedorov, N. I., and Raptunovic, E. S. 1970. [THE PHOTOSYNTHETIC ACTIVITY OF MALE AND FEMALE ASPEN TREES.] Lesoved., Moskva (1), (46-51). [Ru.e., 13 refs.]
The rate of photosynthesis was greater in the ♂ trees, especially in the early part of the growing season, the difference averaging 15-20%.

Hodasevic, S. G. 1964. [STUDY OF THE FLOW OF ELECTRIC CURRENT IN HARDWOODS AND CONIFERS.] Dokl. Akad. Nauk SSSR 155 (4): 967-9. 2 refs. [Ru.] O.R.S.

Holmgren, P., Jarvis, P. G., and Jarvis, M. S. 1965. RESISTANCES TO CARBON DIOXIDE AND WATER VAPOUR TRANSFER IN LEAVES OF DIFFERENT PLANT SPECIES. Physiol. Plant., Copenhagen 18 (3): 557-73. 35 refs. [E.e.]

Il'in, A. M. 1972. [WOOD DENSITY OF MALE AND FEMALE SPECIMENS OF ASPEN DURING THE COURSE OF THE GROWING SEASON.] Lesnoi Zhurnal 15 (4): 25-27 [Ru., 16 ref.]
Wood density of ♂ and ♀ trees changed during the growing season and was directly related to the amount of stored nutrients in the wood.

Il'in, A. M. 1973. [THE SEX RATIO IN ASPEN IN DIFFERENT GROWTH CONDITIONS.] Ekologiya No. 2, 92-93 [Ru., 10 ref. NLL]
Tabulates data on the number of ♂ and ♀ clones of Populus tremula, the mean area of a clone, and the mean number of trees in a clone, on five different sites in the Lipetsk region of S. central Russia: flood-plain, second terrace, slope near watershed, plateau, and ravine. The differences between the ♂ and ♀ clones were not great, but relief of the site caused considerable differences in the sex rations: ♀ trees predominated on the flood-plain and second terrace, and especially in the ravine, and ♂ trees on the drier site, i.e. the slope near the watershed and on the plateau.

Jarvis, P. G., and Jarvis, M. S. 1964. GROWTH RATES OF WOODY PLANTS. Physiol. Plant., Copenhagen 17 (3): 654-66. 62 refs. [E.e.]
A comparison is made of figures for Betula verrucosa, Populus tremula, Pinus sylvestris, Picea abies and Helianthus annuus, kept in a growth room under controlled temperature and light.

Jarvis, P. G., and Jarvis, M. S. 1965. THE WATER RELATIONS OF TREE SEEDLINGS. V. GROWTH AND ROOT RESPIRATION IN RELATION TO OSMOTIC POTENTIAL OF THE ROOT MEDIUM In Water stress in plants. W. Junk, The Hague. pp. 167-82. 12 refs. [E.e.]

Kolovskii, R. A. 1973. [INFLUENCE OF THE RELATIVE HUMIDITY OF THE AIR ON THE VALUE OF THE BIOELECTRIC POTENTIAL OF WOODY PLANTS.] Lesovedenie No. 6, 53-59 [Ru.e., 23 ref.]
Discusses the results of studies made on advance growth (2-3 m high) of Pinus sylvestris and Populus tremula, to determine the influence exerted by r.h. on the metabolic potential via the rate of xylem sap flow.

Keller, T. 1973. CO_2 EXCHANGE OF BARK OF DECIDUOUS SPECIES IN WINTER. Photosynthetica 7 (4): 320-324. [E., 14 ref. ORS]
It is concluded that since bark P was unable to compensate for the respiration losses of roots and shoots even under favourable illumination, it is unlikely that a positive CO_2 balance could be maintained over the winter months in central Europe.

Keller, T., and Beda-Puta, H. 1973. [GAS EXCHANGE OF LEAFLESS SHOOTS IN WINTER.] Schweizerische Zeitschrift fur Forstwesen 124 (6): 433-441. [De.f., 14 ref.]
Root respiration was slightly greater than shoot respiration in Larch and Aspen, and slightly smaller in Ash. Transpiration in the leafless plants was only a fraction of that of evergreen Pines; it was greatest in Ash and least in Aspen.

Kocanovskij, S. B. 1968. [CERTAIN PHYSIOLOGICAL FEATURES OF MALE AND FEMALE ASPEN TREES.] Lesoved., Moskva (2), (14-23). [22 refs. [Ru.e.] N.L.L.]
Studies on Populus tremula in Belorussia showed that the incidence of stem rot was much less in ♀ than in ♂ trees. No significant differences between the sexes were found in growth rate, or the contents of N, ash elements, and leaf pigments, but the peroxidase activity of the leaves of ♀ Aspen was 1·4-4·2 times that of ♂ trees.

Laisk, A., and Oya, V. 1971. [CHANGE IN THE MESOPHYLL RESISTANCE [TO GAS DIFFUSION] OF ASPEN IN RESPONSE

TO RAPID DEHYDRATION OF THE LEAF.] Fiziol. Rast. 18 (3): 553-62. [Ru.e., 35 ref. NLL]

Viil, IU, Laisk, A., Oia, V., and Parnik, T. 1972. [ENHANCEMENT OF PHOTOSYNTHESIS BY OXYGEN PLASTS BY VALINOMICYN.] Akad. Nauk. SSSR Dokl. 204 (5): 1269-1271. Ref. [Ru.]

161.32

Laisk, A. K., and Oia, V. M. 1974. [LEAF PHOTOSYNTHESIS UNDER SHORT PULSES OF CARBON DIOXIDE: CARBOXYLATION REACTION IN VIVO.] Fiziol. Rast. (Mosk) 21 (6): 1123-1131. Ref. [Ru.e.]

163 EMBRYOLOGY

Barna, M. M. 1967. [FEATURES OF THE DEVELOPMENT OF THE ♀ GAMETOPHYTE IN TRIPLOID ASPEN (POPULUS TREMULA L. VAR GIGAS).] Ukr. bot. Z. 24 (6): 42-9. [10 refs. [Ukr,ru.e.] A.P.B]
A detailed study, noting certain anomalies in macrospore development which cause premature fall of flowers and catkins

Nikolic, D. 1971. [STUDY ON THE EFFECT OF P^{32} INCORPORATED IN THE COURSE OF EMBRYOGENY ON YOUNG PLANTS OF SOME FOREST TREE SPECIES.] Sumarstvo 24 (9/10): 3-13. [Sh.e., 28 ref.]
Flowering branches of Populus tremula, Ulmus laevis, and Acer negundo were treated with various doses of P^{32}. The germination % of the seeds produced was reduced by the higher doses, but seedling increment was somewhat stimulated by the lower doses.

164 MORPHOLOGY

Belostokov, G. P. 1966. [STRUCTURE OF THE CONDUCTING SYSTEM OF THE PETIOLE AND MIDRIB OF LEAVES OF CERTAIN WOODY PLANTS.] Nauc. Dokl. Vyss. Skoly (Biol. Nauki), Moskva (3), (128-35). [19 refs. [Ru.] N.L.L.]

Danilov, M. D. 1971. [SEASONAL GROWTH IN SURFACE AREA OF LEAF LAMINAE OF SOME WOODY SPECIES.] Lesoved. (4), (43-9). [Ru.e., 16 ref.]

Il'in, A. M. 1969. [DETERMINING THE SEX OF ASPEN BY THE LEAVES.] Lesoved., Moskva (6), (66-71). [Ru.e., 14 refs.]
Width, length, area, thickness, weight, and venation of leaves differed between the sexes in Populus tremula, but were too much affected by site for reliable identification of sex.

Jacquiot, C. 1964. [STRUCTURE OF EXCISED ROOTS OR OF ORGANS FORMED DE NOVO FROM CAMBIAL TISSUE OF TREES GROWN IN CULTURE.] Repr. from Revue de Cytologie et de Biologie Vegetales, Paris 27, (319-22). 8 refs. [F.f.e.]

Jentys-Szaferowa, J. 1970. (Editor) [VARIABILITY OF LEAVES AND FRUITS OF TREES AND SHRUBS IN THE FOREST ASSOCIATIONS OF THE BIALOWIEZA NATIONAL PARK.] Monographiae Botanicae 32, 238 pp. [Pol.e., 30 ref.] From Plant Breeding Abstracts (1972) 6272-6285.

Ross, V., and Tamm, U. 1974. [BIOMETRIC STUDY ON THE GROWTH OF ASPEN LEAVES.] Metsanduslikud Uurimused 11, 241-258 [Ee.ru.e., 14 ref.]
Growth of leaves in length and width ceased by 20-30 days after flushing. Differences between the two forms of Aspen were not consistent.

164.6

Rowley, J. R., and Erdtman, G. 1967. POLLEN WALL DEVELOPMENT IN POPULUS. Abstr. in Amer. J. Bot. 54 (5, Part 2); 629.
Presents observations on microspores of P. tremula and P. tremula var. gigas from before microspore mitosis until maturation of pollen. The phenomena may be of general significance in the ontogeny of pollen grains.

165 PHYLOGENY, EVOLUTION, HEREDITY, GENETICS AND BREEDING, VARIATION

165.3/.7

Anonymous. 1969. [TREE BREEDING, SELECTION, AND SEED PRODUCTION IN LATVIA.] Izdatel'stvo 'Zinatne', Riga. pp. 255. [Ru.latv.g.e., Many refs. N.L.L.]

Anonymous. 1971. [GENETICS, BREEDING AND SELECTION. PAPERS OF THE 1ST INTER-REPUBLICATION CONFERENCE ON THE PROBLEMS OF GENETICS, BREEDING AND SELECTION.] Vilnius, USSR.) 268 pp. [Ru.] From Plant Breeding Abstracts 43, 3936-3950.

Bakulin, V. T. 1966. A TRIPLOID CLONE OF ASPEN IN THE FORESTS OF THE NOVOSIBIRSK REGION. Genetika, Moskva (11), (56-68). [[Ru.] From abstr. in Pl. Breed. Abstr. (1967) 37 (3): No. 5068.]

Bakulin, V. T. 1968. [VARIABILITY OF ASPEN IN RELATION TO BARK COLOUR IN THE FORESTS OF THE NOVOSIBIRSK REGION.] Lesoved., Moskva (2), (74-80). [6 refs. [Ru.e.] N.L.L.]
Four forms of Populus tremula were distinguished: (a) with light bark, (b) with green bark, (c) with greenish-gray bark, and (d) with grey bark.

Carev, A. P. 1968. [CHARACTERISTICS OF EARLY- AND LATE-FLUSHING FORMS OF ASPEN IN THE CENTRAL FOREST-STEPPE.] Lesn. Z., Arhangel'sk 11 (6): 33-7. [9 refs. [Ru.].]
Investigations in the Voronezh region, south-central Russia, showed that the early-flushing form tended to occur on the higher parts of the terrain (watersheds, upper slopes), to be less resistant to decay, and to have wider crowns, more crooked stems, and smoother and greener bark than the late-flushing form.

Ceremisinov, N. A. 1965. [A SEARCH FOR A DISEASE-RESISTANT ASPEN.] Lesn. Hoz. 18 (7): 52-5. [Ru.]
The green-barked form was found to have the highest resistance to rot and thus to be the most promising for the pulp and paper industry.

Ceschi, I. 1969. [DISTRIBUTION AND CULTIVATION OF POPULUS TREMULA IN CANTON TICINO.] [Mitteilungen,] Schweizerische Pappel-Arbeitsgemeinschaft, Bern No. 16, (1-7). [G. From review in Holzzucht (1970) 24 (2/3): 32. G.]

Demidenko, V. P. 1973. [TRACE ELEMENTS IN THE WOOD OF ASPEN OF DIFFERENT MORPHOLOGICAL FORMS.] Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR 15 (Biol. Nauk No. 3): 122-123 [Ru.e., 9 ref. NLL]
The green-barked form, which is more resistant to heart rot, had higher contents of the physiologically important trace elements, e.g. Mn, Cr, Fe, Co, Cu, Zn, and Ba.

Dolgoseev, V. M. 1969. [PHYSICAL AND MECHANICAL PROPERTIES OF THE WOOD OF EARLY- AND LATE-FLUSHING FORMS OF ASPEN IN THE KIROV REGION.] Lesn. Z. 12 (5): 144-5. [Ru., 4 refs.]
Studies on 10 trees of each form of Populus tremula revealed significant differences between the two forms, wood density and strengths being 6-19% greater in the late-flushing form.

Einspahr, D. W., and Benson, M. K. 1967. GEOGRAPHIC VARIATION OF QUAKING ASPEN IN WISCONSIN AND UPPER MICHIGAN. Silvae Genet. 16 (3): 106-12. [22 refs.]
Natural stands of Populus tremuloides were measured in 5 localities in Wisconsin and Upper Michigan; wood samples were obtained, and soil data collected. There was a well defined south-to-north trend of decreasing sp. gr. of the wood, but there was no geographical trend of fibre length, fibre strength, pulp yield, or any tree growth characteristics. Fibre length appears to be influenced by genetic and local site factors, and is correlated with sp. gr., height and volume increment. On the other hand, there was a negative correlation between fibre strength and sp. gr., volume and diam. increment. The significance of these findings for selective breeding is discussed.

Einspahr, D. W., Benson, M. K., and Peckham, J. R. 1968. WOOD AND PULP PROPERTIES OF 5-YEAR-OLD DIPLOID, TRIPLOID, AND TRIPLOID HYBRID ASPEN. Tappi 51 (2): 72-5. [17 refs.]
Tabulates and discusses fibre length, sp. gr. and pulp properties of two triploid Populus tremuloides clones, two triploid hybrid families (P. tremuloides X P. tremula), and two families of diploid P. tremuloides after 5 growing seasons in N. Wisconsin.

Hattemer, H. H., and Seitz, F. W. 1967. [SOME RESULTS OF FIELD TRIALS [IN W. GERMANY] WITH ASPEN HYBRIDS.

CROSSES OF THE YEARS 1953 and 1958.] Silvae Genet. 16 (1): 6-13. [60 refs. [G.g.e.].]
Tentative evaluations of combining ability from the small number of diallel crosses obtained gave, on the average, a higher value for general than for specific combining ability.

Jarvekulg, L., and Tamm, U. 1970. [TRIPLOID ASPEN IN ESTONIA.] Metsanduse Tead. Uurim. Lab. Metsandusl. Uurim. 8, (10-35). [Est.ru.e., 22 refs.]

Jovancevic, M. 1965. [EXPERIENCE IN THE TESTING OF SELECTED SUPERIOR TREES THROUGH VEGETATIVE PROPAGATION IN JUGOSLAVIA (BOSNIA).] Tagungsberichte, Deutsche Akademie der Landwirtschaftswissenschaften zu Berlin No. 69, (67-75). [G.g.ru.e.] C.G.B.

Kundzin'sh, A. V. et al. 1972. [FOREST TREE BREEDING AND SELECTION.] Lesnaya selektsiya. Moscow, USSR, Lesnaya Promyshlennost'. 200 pp. [Ru., 69 ref. NLL]
A practical handbook dealing mainly with the principles of selection of plus-trees and plus-stands in Latvia.

Mojrov, S. L. 1965. [AN ECONOMIC EVALUATION OF THE DIFFERENT BIOLOGICAL FORMS OF POPULUS TREMULA.] Lesn. Hoz. 18 (8): 15-7. [Ru.]
The light-barked form is the most valuable for this area, and should be given preference, wherever possible, over the next best, but more common, green-barked form.

Pospisil, J. 1965. [THE POSSIBILITIES OF USING POLYPLOIDY IN BREEDING POPULUS TREMULA.] Sborn. Vysoke Skoly Zemed., Brno (Rada C) (3), (187-209). [23 refs. [Cz.cz.ru.e.g.].]

Pospisil, J. 1965. [THE USE OF NATURAL POLYPLOIDS OF POPULUS TREMULA FOR HYBRIDIZATION WORK.] Sborn. Vysoke Skoly Zemed., Brno (Rada C) (3), (211-28 + 4 photos). [12 refs. [Cz.cz.ru.e.g.].]
Describes experiments made in Czechoslovakia in 1959-62, giving data obtained so far on chromosome counts and growth characteristics of plants produced from ♀ diploid X ♂ triploid or tetraploid crosses.

Rohmeder, E. 1966. [THE DEVELOPMENT OF FOREST TREES FROM WILD PLANTS TO CULTIVARS.] Forstwiss. Cbl. 85 (1/2): 1-16. 19 refs. [G.g.]
Discusses the development of forest tree breeding, including cross-breeding of Aspen of different provenances.

Sarvas, R. 1969. GENETICAL ADAPTATION OF FOREST TREES TO THE HEAT FACTOR OF THE CLIMATE. [Pap.] 2nd FAO/IUFRO World Consult. For. Tree Breed., Washington, No. FO-FTB-69-2/15, pp. 11. [14 refs. [E.e.].]

Schonbach, H. 1967. [INCREASING YIELDS BY INTERSPECIFIC HYBRIDIZATION OF ASPEN AND LARCH.] Repr. from Wiss. Z. Tech. Univ. Dresden 16 (2): 563-7. [10 refs. G.g.].]
Trials confirm the growth superiority of most, though not all, hybrids, and appear to indicate greater resistance to drought, weed competition and game damage than that of the parents.

Smilga, Ja. Ja. 1965. [AN ECONOMIC EVALUATION OF THE DIFFERENT BIOLOGICAL FORMS OF POPULUS TREMULA.] Lesn. Hoz. 18 (8): 12-5. [Ru.]
Although the dark-grey is the commonest, the green and light-grey forms are superior and are to be propagated and introduced on a large scale.

Sokolowski, A. W. 1966. [A VALUABLE FORM OF POPULUS TREMULA OCCURRING IN AUGUSTOW FOREST.] Sylwan 110 (8): 21-6. [2 refs. [Pol.ru.e.].]
Describes two fragments of stands containing a high proportion of large healthy Aspen (d.b.h. up to 80 cm., height up to 38 m., at 80-90 years). Both stands occur on gleyed podzolic soil developed from loose sand.

Vznuzdaev, N. A., et al. 1969. [JOINT STUDY OF ASPEN FORESTS, WITH REFERENCE TO THE VARIETY OF FORMS IN ASPEN.] Izdatelstvo 'Nauka', Moscow. pp. 77. [89 refs. [Ru.].]

Winton, L. [L.], and Einspahr, D. W. 1970. TETRAPLOID ASPEN PRODUCTION USING UNREDUCED TRIPLOID POLLEN. For. Sci. 16 (2): 180-2. [5 refs.]
Discusses the previous production of tetraploids from crosses between Populus tremuloides and a tetraploid P. tremula, and notes the production of one fast-growing tetraploid by the use of pollen from a natural triploid P. tremuloides to pollinate normal (diploid, ♀ flowers of this species.

165.53

Guzina, V. 1974. ISOENZYMES OF PEROXIDASES IN GENETIC STUDIES OF POPLAR. Genetika, Yugoslavia 6 (1): 63-68. [Sh.e., 8 ref. From Plant Breeding Abstracts 45, 3990.]
Zymograms of isoperoxidases, obtained by starch-gel electrophoresis, were prepared for 93 three-month-old seedlings of a half-sib family of Populus tremula.

168 HISTOLOGY

Jacquiot, C. 1964. [APPLICATION OF THE TECHNIQUE OF VEGETABLE TISSUE CULTURE TO THE STUDY OF SOME PROBLEMS OF TREE PHYSIOLOGY.] Ann. Sci. for., Nancy 21 (3): 309-473 + 77 photos, 3 tbls. 213 refs. [F.f.e.g.]
Reports extensive studies on cambial activity, tissue organization and organogenesis, in which cambial tissue from 20 common forest tree species was cultured.

17 SYSTEMATIC BOTANY

172.8 EUMYCETES (TRUE FUNGI)

Davidson, R. W., Francke-Grosmann, H., and Kaarik, A. 1967. A RESTUDY OF CERATOCYSTIS PENICILLATA AND REPORT OF TWO AMERICAN SPECIES OF THIS GENUS FROM EUROPE. Mycologia 59 (5): 928-32. [7 refs. O.R.S.]
C. bicolor and C. tremulo-aurea (a fungus common on live Populus tremuloides, isolated from cankers) were identified for the first time in Europe from Norway Spruce logs and Populus tremula respectively in Sweden.

Hiratsuka, Y. 1968. MORPHOLOGY AND CYTOLOGY OF AECIOSPORES AND AECIOSPORE GERM TUBES OF HOST ALTERNATING AND PINE-TO-PINE RACES OF CRONARTIUM FACCIDUM IN NORTHERN EUROPE. Canad. J. Bot. 46 (9) 1119-22 + 21 photomicrographs). [9 refs. O.R.S.]

174 EMBRYOPHYTA. SIPHONOGAMIA. SPERMATOPHYTA. PHANEROGAMS. SEED-PLANTS IN GENERAL.

Anonymous. 1964. [INVESTIGATIONS ON THE NATURE OF WOODY SPECIES.] Izdatel'stvo Akademii Nauk Latvijskoj SSR Riga. pp. 171. Many refs. [Ru.latv.g.] P.R.

Petrov, S. A. 1964. [VARIABILITY OF THE TREE SPECIES IN THE PINE FOREST OUTLIERS OF THE KAZAKHSTAN MELKOSOPOCNIK [LOW-HILLS AREA].] Bot. Z. 49 (12) 1789-92. 19 refs. [Ru.]

176.1 DICOTYLEDONEAE

Białobok, S. 1964. STUDIES ON POPULUS TOMENTOSA CARR Arboretum Kornickie, Poznan 9, (5-35 + 1 tbl.). 34 refs [E.e.pol.ru.]
It is concluded that P. tomentosa is a (probably natural) hybrid originating in W. central China, between some geographical variety of P. alba s.l. and, most probably, P. tremula var. davidiana.

Bird, C. D. 1969. BRYOPHYTES OF THE ASPEN PARKLAND OF WEST CENTRAL CANADA. Canad. J. Bot. 47 (1): 187-212. [43 refs. Smry.]

Bunusevac, T., and Jovanovic, S. 1969. [TWO NEW FORMS OF LOWLAND ASPEN, POPULUS TREMULA VAR. VILLOSA.] Topola, Beograd 13 (71/72): 3-16. [Serb.g.]

Bunusevac, T., and Jovanovic, S. 1974. [TWO NEW FORMS OF THE LOWLAND ASPEN (POPULUS TREMULA L. VAR VILLOSA (LANG) WESM.).] Bull. Cl. Sci. Math. Nat. Acad. Serbe Sci. Arts (new ser.) 51 (13): 63-67. Ref.

Chebotina, M. Y., and Molchanova, I. V. 1972. [EFFECT OF PLANT LITTER ON THE VERTICAL MIGRATION OF Sr^{90} IN THE SOIL.] Ekologiya No. 6 (84-85). [Ru., 6 ref.]

Gramuglio, G. 1964. [FURTHER INVESTIGATIONS ON POPULUS TREMULA IN ITALY: MORPHOLOGICAL STUDIES.] Pubbl. Cent. Sper. Agric. For., Roma 7, (221-50 + 1 plate, 1 map). 21 refs. [It.it.e.e.]

Samgin, P. A., and Bakhtin, O. V. 1971. [USE OF ARBORICIDES TO SUPPRESS THE SUCKERING OF ASPEN.] Lesn. Khoz. (10), (40-1). [Ru.]

Sylven, N. 1966. [VARIATIONS IN SWEDISH ASPEN WITH REFERENCE TO LEAF SHAPE.] Bot. Notiser 119 (2): 169-76. [Sw.] [O.B.D.]

18 PLANT ECOLOGY

Anonymous. 1965. [ECOLOGY OF WOODY PLANTS.] Izdatel'stvo 'Nauka i Tehnika', Minsk. pp. 134. [Many refs. [Ru.] N.L.L.]

Nikolovski, T., and Matveieva, J. 1974/1975. [ECOLOGICAL TAXONOMY OF POPULUS TREMULA IN MACEDONIA.] Topola 18/19 (103/106): 122-124. [Sh.e.ru., 8 ref.]
Discusses the wide ecological spectrum of P. tremula in Macedonia (where it finds its optimum in the Beech zone) and distinguishes six forms of the type variety and one form of the variety villosa, listing the associations in which they occur.

Truchanowicz, J. 1970. [OSIKA (POPULUS TREMULA L.); EUROPEAN ASPEN (POPULUS TREMULA L.).] Monogr. Bot. 32: 115-125. [Pol.e.]

Wolterson, J. F. 1971. [ASPEN IN HOLLAND.] Populier 8 (5): 88-93. [Nl., 12 ref.]
A summary of information on Populus tremula, including soil requirements, plant communities in which it occurs, general ecology, and forms differing in habit. Some information is also given on related species in sect. Leuce.

181 MODE OF LIFE, AUTECOLOGY. SILVICULTURAL CHARACTERS OF TREES

Il'in, A. M. 1972. [DYNAMICS OF POPULUS TREMULA STANDS AND ADMIXTURES OF POPULUS TREMULA IN STANDS.] Les. Khoz. 10: 34-35. [Ru.]

Ivanescu, D. 1967. [POPULUS TREMULA.] Editura Agro-Silvica, Bucharest. pp. 179 + 1 map. [114 refs. [Rum.f.ru.] Price Lei 12.]
A comprehensive monograph covering ecology, silviculture and wood properties, with particular reference to Rumanian conditions.

Rebane, H. 1965. [SILVICULTURAL CHARACTERISTICS OF ASPEN IN YOUNG SPRUCE/HARDWOOD STANDS OF THE MERCUVIALIS/AEGOPODIUM SITE TYPE.] Metsanduse Tead. Uurim. Lab. Metsandusl. Uurim., Tallium No. 4, (121-38). [29 refs. [Est.ru.g.ru.g.].]

Trebuhova, T. V. 1965. [THE POSITION OF ASPEN IN THE SAMARA FORESTS. DNEPROPETROVSK REGION.] Ukr. bot. Z. 22 (2): 71-4. 11 refs. [Ukr.ru.e.] A.P.B.
A note on the habitat of Populus tremula in this region, with brief descriptions of the stands in the floodplain, on sands, in ravines, and on the fourth terrace.

181.1

Doncev, Z. B. 1964. [ECOLOGICAL AND GEOGRAPHICAL FEATURES OF THE DISTRIBUTION AND LOCALIZATION OF CERTAIN TREE AND SHRUB SPECIES IN N. E. BULGARIA.] Nauc. Trud. Lesoteh. Inst., Sofija 12, (60-74). 15 refs. [Bulg.f.]
Lack of warmth was the limiting factor for Paliurus aculeatus, Celtis australis, Rhus coriaria and Colutea cilicica, and lack of soil moisture for Fagus sylvatica, Acer pseudoplatanus, Staphylea pinnata, Populus tremula, Quercus sessiliflora and Carpinus betulus.

181.2

Dvorakovskii, M. S., and Ermolin, I. E. 1972. [FUNCTIONAL FEATURES OF THE OPTICAL PROPERTIES OF THE LEAVES OF OAK ADVANCE GROWTH IN DIFFERENT ECOLOGICAL CONDITIONS.] Vestn. Mosk. un-ta Biol., pochvoved. No. 4, 114-116 [Ru.e.] From Referativnyi Zhurnal (1973) 1.56.42. Ru. NLL.

Rudik, K. I. 1964. [THE ACOUSTICS OF FOREST.] Lesn. Z., Arhangel'sk 7 (2): 26-9. 3 refs. [Ru.]

181.3

Anonymous. 1964. [THE EFFECT OF SOIL CONDITIONS ON THE GROWTH OF WOODY PLANTS.] Izdatel'stvo 'Nauka i Tehnika', Minsk. pp. 115. Many refs. [Ru.] N.L.L.

181.31

Grupce, R. 1967. [MOISTURE DEFICIT OF CERTAIN WOODY PLANTS.] God. Zborn. Zemj.-Sum. Fak. Univ. Skopje (Sum.) 20, (75-83). [12 refs. [Maced.e.].]

Il'in, A. M. 1970. [VARIATION IN THE WOOD MOISTURE CONTENT OF MALE AND FEMALE ASPEN DURING THE GROWING SEASON.] Lesn. Z. 13 (3): 25-8. [Ru.]
Sex and site conditions affected the wood m.c., which was consistently higher in the ♀ trees on both site types, and was consistently higher on the C_2 site [fairly rich, fresh] than on the C_3 site [fairly rich, moist] for both sexes.

Kurbatskii, N. P. 1972. [SEASONAL VARIATIONS IN THE MOISTURE CONTENT OF THE NEEDLES OF EVERGREEN TREE SPECIES OF THE TAIGA.] Lesovedenie No. 2, 44-50 [Ru.e., 10 ref.]

Raskatov, P. B., and Fremin, V. M. 1973. [EFFECT OF THE 1972 DROUGHT ON THE INCREMENT OF CERTAIN TREE SPECIES.] Lesnoi Zhurnal 16 (4): 5-8 [Ru., 3 ref.]
Betula verrucosa, Populus tremula and Quercus robur s.l. were more affected by the drought than Pinus sylvestris, Fraxinus excelsior and Tilia cordata.

Veretennikov, A. V. 1964. [THE EFFECT OF SURPLUS SOIL MOISTURE ON THE TRANSPIRATION CAPACITY OF WOODY PLANTS.] Fiziol. Rast. 11 (2): 274-8. 17 refs. [Ru.ru.e.] A.P.B.

181.311

Nestsiarovich, M. D., Dziarugina, T. F., and Aliker, B. S. 1970. [THE EFFECT OF SOIL MOISTURE ON THE GROWTH OF YEAR-OLD SEEDLINGS OF POPULUS TREMULA AND ULMUS LAEVIS.] Minsk. Belaruskaya Akad. Navuk. Vestsi. Ser. Biyalahichnykh. Navuk. 4: 20-25. [Bel.]

181.32/.34

Chebotina, M. Ya. 1971. INFLUENCE OF PLANT EXTRACTS ON THE MOBILITY OF Fe^{59} AND Co^{60} IN SOIL UNDER CONDITIONS OF DYNAMIC LABORATORY EXPERIMENTS. Soviet Radiochemistry 13 (5): 756-759 [E., 6 ref. ORS] Translated from Radiokhimiya 13, 740-744. Ru.
The ability of the extracts to mobilize the radionuclides decreased in the order: Populus > Tilia > Pinus. At the end of the experiment the Co^{60} was uniformly distributed throughout the soil, whereas in the control it was sorbed mainly by the topmost soil layer. The content of Fe decreased uniformly through the soil layers under all experimental conditions.

Mahonina, G. I. 1965. [DISTRIBUTION OF Fe^{56}, Co^{60}, Zn^{65}, Sr^{90} AND Cs^{137} IN PINUS SYLVESTRIS, LARIX SUKACZEWII, POPULUS TREMULA AND BETULA VERRUCOSA.] Bjull. Mosk. Obsc. Ispyt. Prir. (Otd. Biol.) 70 (2): 120-3. [Ru.e.] N.L.L.

Remezova, G. L. 1964. [ACCUMULATION OF ORGANIC MATTER DURING THE DEVELOPMENT OF THE HERB COVER OF AN OAK FOREST.] Bot. Z. 49 (6): 894-900. 20 refs. [Ru.]

181.343

Sokolov, A. A. 1969. [EFFECT OF THE ROOTS OF NORWAY SPRUCE, BIRCH AND ASPEN ON THE PHYSICAL AND CHEMICAL PROPERTIES OF SOD-PODZOLIC SOILS.] Lesoved., Moskva (6), (53-9). [Ru.e., 6 refs.]

181.35

Jacquiot, C. 1968. [GERMINATION OF SPORES OF MYCORRHIZA-FORMING BASIDIOMYCETES, IN THE PRESENCE OF EXCISED ROOTS OF FOREST TREES, GROWN IN VITRO.] C.R. Acad. Sci., Paris 267D (6): 617-8. [1 ref. [F.f.]. O.R.S.]

181.36

Eliasson, L. 1968. DEPENDENCE OF ROOT GROWTH ON PHOTOSYNTHESIS IN POPULUS TREMULA. Physiol. Plant., Copenhagen 21 (4): 806-10. [12 refs. [E.e.].]
When leaves were deprived of light, root growth decreased within 24 hr. and the roots ceased growth completely during the second or third day. When leaves were removed or the tissue in a stem section below the leaves was killed, root growth ceased within 24 hr.

Harabin, Z. 1970. [ROOTING OF CERTAIN TREE AND SHRUB SPECIES ON ASH DUMPS.] Sylwan 114 (7): 45-50. [Pol.ru.e., 3 refs.]

Il'in, A. M. 1973. [THE ROOT SYSTEMS OF MALE AND FEMALE ASPEN.] In Lesovodstvo, lesnye kul'tury i pochvovedenie Vyp. I. Leningrad, USSR; Izdatel'stvo Leningradskogo Universiteta. 49-53 [Ru., 7 ref. BLL]
The general development of the root system as measured by the total cross-sectional area of the main (skeletal) roots was similar in male and in female trees, but the male trees had a larger number of horizontal roots. The male trees also produced significantly more suckers than the females.

Panarin, I. I. 1971. [STRUCTURE, BIOMASS AND LINEAR GROWTH OF ROOT SYSTEMS OF TREES AND SHRUBS IN DIFFERENT FOREST TYPES OF THE CHITA TRANS-BAIKAL REGION.] Zap. Zabaikal. Fil. Geogr. Obshch. SSSR (54), (7-15). [Ru., From abstr. in Referat. Zh. 1971 (12.56.60). Ru., NLL]

Straub, R. 1966. [THE RELATIONSHIP BETWEEN AIR AND SOIL TEMPERATURES AND THE INITIATION OF ROOT GROWTH IN ASPEN SEEDLINGS.] Schweiz. Z. Forstw. 117 (1): 60-7. 1 ref. [G.g.]
In a study of 36 one-year seedlings of 3 provenances planted in glass-fronted containers, in 3 environments, root growth started later than shoot growth. The time lag (5 to 19 days) and total root growth appeared to be related to shoot development, which varied with temperature and photoperiod. Differences between provenances were small.

Sokolov, A. A. 1967. [ROOT OCCUPATION OF THE A_1 HORIZON OF SODDY PODZOLIC SOIL BENEATH NORWAY SPRUCE, BIRCH, AND ASPEN CANOPIES.] Lesoved., Moskva (2), (83-6). [8 refs. [Ru.e.].]
The quantity of absorbing roots (< 0·4 mm. in diameter) as a proportion of total root volume in this horizon was highest in the Spruce stand (33·9% vs. 30·8 and 26·6% in the Birch and Aspen stands respectively).

181.4

Gubareva, V. A. 1964. [THE EFFECT OF LEAF AND ROOT EXUDATES ON THE GROWTH OF OAK.] Lesn. Hoz. 17 (12): 22-4. [Ru.]

Sargunova, V. A. 1969. [EFFECT OF CERTAIN ALLELOPATHIC FACTORS ON THE LABORATORY GERMINATION OF LARIX SUKACZEWII SEEDS.] Lesn. Z., Arhangel'sk 12 (2): 149-51. [Ru., 7 refs.]
Aqueous extracts of Birch litter and of Aspen litter significantly reduced germinative energy, though not germination %, whereas a mixture of these extracts stimulated germinative energy but scarcely affected germination %. Root extracts of Aspen significantly reduced germinative energy.

181.5

Dolgoseev, V. M. 1968. [RATIO OF MALE AND FEMALE ASPEN INDIVIDUALS IN THE FORESTS OF THE KIROV REGION.] Lesoved., Moskva (4), (97-9). [9 refs. [Ru.e.] N.L.L.]
Studies in three Aspen forest types showed that in all three the sex ratio was close to 1 : 1 when clones and individual trees of seedling origin were counted. On the basis of the absolute number of stems, the ratio changed from a preponderance of ♂ stems on the driest site to a preponderance of ♀s on the wettest.

Etholen, K. 1974. [THE EFFECT OF TIME OF FELLING ON THE COPPICING OF BETULA PUBESCENS AND POPULUS TREMULA ON REGENERATION AREAS IN NORTHERN FINLAND.] Folia Forestalia, Institutum Forestale Fenniae No. 213, 16 pp. [Fin.e., 18 ref.]
In general, the time of felling had little effect on the number of coppice shoots; the smallest numbers were found after felling in the dry season and during autumn frosts, and the largest after periods of rain or in early spring.

Petrov, V. V. 1967. [THE BIOLOGY OF ASPEN ROOT SUCKERS.] Nauc. Dokl. Vyss. Skoly (Biol. Nauki), Moskva 10 (4): 76-9. [6 refs. [Ru.] N.L.L.]

Volkovic, V. B. 1966. [THE RATIO OF ♂ *AND* ♀ CLONES AND TREES OF ASPEN IN FORESTS OF THE LENINGRAD REGION.] Lesn. Z., Arhangel'sk 9 (2): 22-4. [5 refs. [Ru.].]

181.6

Astrologova, L. E. 1972. [PRODUCTIVITY OF THE PHYTOMASS OF YOUNG SCOTS PINE/BROADLEAVED STANDS.] Tr. Arkhang. Lesotekhn. Inst. No. 34, 32-38 [Ru.] From Referativnyi Zhurnal (1973) 6.56.44. Ru. NLL.

Bos, N. 1974. [CROWN FORM AND HABIT OF TREES GROWN IN STANDS.] Revista Padurilor-Industria Lemnului, Silvicultura si Exploatarea Padurilor 89 (4): 164-170. [Ro., 4 ref.]

Ignat'eva, L. A. 1966. [PRODUCTIVITY OF THE HERBACEOUS COVER IN THE FOREST COENOSES OF THE RIVER OB REGION [W. SIBERIA].] Bot. Z. 51 (2): 196-209. 14 refs. [Ru.e.]

Kostylev, A. S., Kudlova, N. A., and Sergol'd, O. E. 1969. [SELF-PRUNING OF ASPEN.] Sborn. Nauc.-Issled. Rabot po Lesn. Hoz. Leningr. Nauc.-Issled. Inst. Lesn. Hoz. (12), (123-34). [[Ru.e.] From abstr. in Referat. Z., Moskva (8.56.37). [Ru.] N.L.L.]
A study of branch death, decay, and self-pruning in natural Aspen stands in various parts of the U.S.S.R.

Margailik, G. I. 1973. [THE PHOTOSYNTHETIC PRODUCTIVITY OF FOREST STANDS IN BELORUSSIA.] Lesnoi Zhurnal 16 (5): 165-167 [Ru., 26 ref.]

Smirnov, V. V. 1971. [BIOMASS IN SOME FOREST PHYTOCOENOSES OF THE EUROPEAN PART OF THE USSR.] Moscow, USSR, Izdatel'stvo Nauka. 361 pp. [Ru.e., 347 ref. NLL]

Smirnov, V. V. 1964. [SEASONAL GROWTH OF THE MAIN WOODY SPECIES.] Izdatel'stvo 'Nauka', Moscow. pp. 167. 112 refs. [Ru.] N.L.L.

Volkovic, V. B. 1966. [COMPARATIVE DIMENSIONS OF MALE AND FEMALE ASPEN.] In Materialy Naucnotehniceskoj Konferencii, 1966 Vyp. 2. Leningradskaja Lesotehniceskaja Akademija pp. 73-8. [[Ru.] From abstr. in Referat. Z., Moskva 1967 (5.56.108). [Ru.] I.F.B.]
Continued studies showed that there was little difference between ♂ and ♀ Populus tremula trees in growth. Only very abundant fruiting reduced the growth of ♀ trees, and such fruiting occurs only very rarely in Aspen and then only at stand margins.

181.8

Kairiukstis, L. 1968. THE GROWTH OF TREES DURING VEGETATIVE PERIOD. Transl. Dep. For. Can. No. 207, pp. 48 [4 refs Transl. from Lietuvos Misku Ukio Mokslinio Tyrimo Instituto Darbai 1962 7, (3-38). [Lith.]

182 SYNECOLOGY, PLANT SOCIOLOGY

182.1

Burks, H. H. 1970. STUDIES IN THE VEGETATIONAL HISTORY OF SCOTLAND. I. A POLLEN DIAGRAM FROM ABERNETHY FOREST, INVERNESS-SHIRE [SCOTLAND]. J. Ecol. 58 (3): 827-46 + 2 pollen diagrams. [51 refs.]

182.2

Penev, N. 1964. [GENERAL PATTERNS IN THE NATURAL REPLACEMENT OF CERTAIN STANDS BY HIGH-YIELDING TWO-STOREYED STANDS.] Gorskostop. Nauka, Sofija 1 (4): 7-27. 7 refs. [Bulg.ru.g.]

182.4

Byazrov, L. G. 1971. [EPIPHYTIC LICHENS IN ASPEN STANDS OF DIFFERENT AGES IN THE MOSCOW REGION.] Byull. Mosk.

)bshch. Ispyt. Prir. (Otd. Biol.) 76 (4): 111-7. [Ru.e., 41 ref. NLL]
)escribes the lichen flora on the stems of trees aged 35, 55, and 75 'ears, indicating changes in its composition and position with tree ge.

Hobodjan, M. P. 1967. [FORESTS WITH SAMBUCUS UNDER-VOOD IN THE UKRAINIAN POLES'E.] Ukr. bot. Z. 24 (4): 70-5. 15 refs. [Ukr.ru.e.] A.P.B.]

182.5

Aussenac, G., and Becker, M. 1968. [ECOLOGY OF A FOREST ON HYDROMORPHIC SOILS: THE FOREST OF CHARMES (VOSGES). A METHOD FOR THE DYNAMIC STUDY OF A FOREST.] Ann. Sci. for., Paris 25 (4): 291-332 + 1 map). [29 refs. F.f.e.g.].]

187 VEGETATION TYPES

Grigora, I. M. 1972. [FOREST BOG COMMUNITIES CONTAINING QUERCUS ROBUR IN THE ZHITOMIR POLES'E REGION.] Ukrains'kii Botanichnii Zhurnal 29 (6): 723-730 [Ukr.e., 11 ref. APB]

Gives details of the peat chemistry, mensurational characteristics, and floristic composition of 10 forest bog associations in which Q. robur appears in this region of the Ukraine. The associations are all dominated by Populus tremula and/or Pinus sylvestris, with various species of Sphagnum.

Kamysev, N. S. 1967. [WATERSHED SPHAGNUM BOGS OF THE OKA/DON LOWLAND.] Bjull. Mosk. Obsc. Ispyt. Prir. (Otd. Biol.) 72 (2): 66-75. [31 refs. [Ru.e.] N.L.L.]
Describes the flora of these transitional bogs, which includes Betula spp., Pinus sylvestris. and Populus tremula.

Kiseleva, K. V. 1965. [THE ASPEN FORESTS OF THE KLINSKO-DIMITROVSKAJA RIDGE, AND THEIR DEVELOPMENT.] Bot. Z. 50 (4): 567-71. 7 refs. [Ru.]

Nitsenko, A. A. 1972. [STUDY OF THE FOREST TYPES FORMED BY SMALL-LEAVED DECIDUOUS TREES IN THE EUROPEAN PART OF THE USSR.] Tipologiya melkolistvennykh lesov evropeiskoi chasti SSSR. Leningrad, USSR, LGU. 138 pp. [Ru., 186 ref. NLL]

2 SILVICULTURE

22 SILVICULTURAL SYSTEMS. CONSTITUTION AND COMPOSITION OF STANDS; FORMS OF STAND

221 HIGH FOREST SYSTEMS

Nabatov, N. M. 1972. [SHELTERWOOD FELLINGS IN SPRUCE/BIRCH STANDS.] Lesnoe Khozyaistvo No. 2, 31-34 [Ru.]

226 CHANGES OF SILVICULTURAL SYSTEM. CONVERSION (BY SYSTEM OR SPECIES)

Turkin, A. S., and Nabatov, N. M. 1964. [SHELTERWOOD FELLINGS IN BIRCH STANDS.] Lesn. Hoz. 17 (4): 21-3. 1 ref. [Ru.]
Gives details of a mechanized shelterwood felling in a mature Birch/Spruce/Aspen stand (6/3/1) with Spruce forming 20% of the second storey and a good Spruce underwood and natural regeneration.

Zeltov, N. M. 1966. [INCREASING THE PRODUCTIVITY OF THE CNINSK FORESTS BY CONVERSION OF LOW-VALUE STANDS.] Sborn. Rabot Lesn. Hoz. Vsesojuz. Nauc.-Issled. Inst. Lesovod. No. 51, (3-22). [Ru.]

228 CONSTITUTION AND COMPOSITION OF STANDS; FORMS OF STAND

Chuenkov, V. S. 1974. [PRODUCING ECONOMICALLY DESIRABLE STANDS.] Lesnoe Khozyaistvo No. 7, 67-71 [Ru., 6 ref.]

Danilin, M. A. 1965. [AGE STRUCTURE OF ASPEN STANDS OF THE KRASNOYARSK INSTRUCTIONAL AND EXPERIMENTAL LESKHOZ.] Lesn. Z. Arhangel'sk 8 (3): 34-6. 3 refs. [Ru.] 3 tbls.
From age determinations on 2967 trees felled in various pure stands, the author concludes that Aspen suckers continue to appear on felled areas and burns for several years, thus leading to the formation of uneven-aged stands.

Hegre, A., and Langhammer, A. 1967. [A CONTRIBUTION TO DISCUSSION ON MIXTURES.] Meldinger fra Norges Landbrugshogskole, Vollebekk 46 (9): pp. 30. [70 refs. [Nor.nor.g.g.].]
Describes the establishment and treatment of a mixture established in 1947 (2 + 0 Aspen and 2 + 2 Spruce, planted as alternate trees), and gives graphs and tables showing height, d.b.h., volume, increment, spacing, etc. in the period up to 1966.

Moiseenko, F. P. 1974. [THE ROLE OF TREES OF DIFFERENT GROWTH CLASSES IN THE FORMATION OF THE STANDING VOLUME.] Lesnoe Khozyaistvo No. 3, 36-39 [Ru., 7 ref.]
Analyses data on the increment of trees of different Kraft growth classes at different ages in Aspen stands of site class Ia in Belorussia.

23 REGENERATION AND FORMATION OF STANDS

231 NATURAL REGENERATION

Il'in, A. M., and Fedotov, N. E. 1972. [EFFECT OF FELLING SEASON ON THE SUCKERING OF ASPEN AND THE FORMATION OF YOUNG STANDS.] Lesnoi Zhurnal 15 (5): 42-47 [Ru., 15 ref.]
Plots in a stand of Populus tremula 45 years old in S. central Russia were felled in April, May, and each month from July to December. The number of suckers produced was by far the greatest after the April felling (averaging 905 suckers per tree) and next greatest after the May felling (640 per tree).

232 ARTIFICIAL REGENERATION

232.1

Langhammer, A. 1973. [RESEARCH WITH HYBRID ASPEN IN NORWAY.] Meld Nor Landbrukshogsk 52 (9): 36 p., map. Ref. [Nor.]

232.13

Benson, M. K., and Einspahr, D. W. 1967. EARLY GROWTH OF DIPLOID, TRIPLOID AND TRIPOLOID HYBRID ASPEN. For. Sci. 13 (2): 150-5. [12 refs.]
Simple correlations between sp.gr. and increment show that rapid increment has no adverse effect on sp.gr.

Langhammer, A. 1973. [A TRIAL OF HYBRID ASPEN IN NORWAY.] Meldinger fra Norges Landbrukshogskole 52 (9): 36 pp. [Nor.de., 11 ref.]
A significant relation was found between quality (stem form, health etc.) height at 3 years and mean height of the crosses at 16 years of age. The height differences between the 10 tallest hybrids and the pure P. tremula at age 16 years represented an increase in height growth of 63% in the hybrids.

Larsen, C. S. 1965. [THE HYBRID ASPEN [POPULUS TREMULA X P. TREMULOIDES] AT SVENSTRUP.] Dansk Skovforen. Tidsskr. 50 (1): 1-16. [Dan.]
Discusses the development of the hybrid, its increased propagation, its diseases and pests, and its growth in mixed plantings (e.g. with Acer pseudoplatanus and Ash), at Svenstrup, Denmark.

Seitz, F. W. 1971. STEIGERUNG DES JUGENDWACHSTUMS DURCH DIE KREUZUNG VERWANDTER PAPPELARTEN. Allgem. Forstz., Munchen 26 (39): 2. Umschl. S., [7 Abb.]

232.311

Haasemann, W. 1966. [ASPEN BREEDING MATERIAL FROM NORTH-EAST POLAND.] Sozial. Forstw., Berl. 16 (12): 363-5. [5 refs. [G.].]

Gives increment data for selected plus-trees of Populus tremula from which scions have been collected in connexion with the E. German tree-breeding programme. The reason for the superior growth of the Polish provenances is discussed.

232.312

Finta, I., Marjai, Z., and Markhot, J. 1964. [MECHANIZED PREPARATION OF ASPEN SEED.] Erdesz. Kutatas., Budapest 60 (1/3): 157-70. 1 ref. [Hu.hu.ru.g.]
Suitable apparatus of the forced-draught, warm-air type has now been tested for cleaning and drying this seed. Nearly 50% more seed was obtained than by hand rubbing. On account of the temperature used (60-65° C.), germination was poorer but, in spite of this, the seedling yield was 25-35% higher than by the older method.

232.322

Kosourov, Ju. F., and Ignatenko, V. K. 1968. [APPLICATION OF ASH AND BURNING OF THE SOIL IN THE PRODUCTION OF HEALTHY ASPEN SEEDLINGS.] Lesn. Hoz. (5), (46-8). [Ru.]
The numbers and growth of Aspen seedlings on the treated plots were superior to those on untreated control plots, and soil burning and ash spreading are recommended as nursery techniques for the production of commercial planting stock.

232.323

Ivanescu, D. 1965. [SOWING POPULUS TREMULA SEED IN THE NURSERY.] Rev. Padurilor 80 (2): 62-6. 7 refs. [Rum.ru.g.e.]

232.325.24

Thorup, S. 1974. [CHEMICAL CONTROL OF POPULUS TREMULA.] Res. Norw. Agric. 25 (6): 593-614. [Dan.]

232.328

Glazyrin, V. M., and Matskova, L. G. 1971. [RESULTS OF EXPERIMENTS ON THE ARTIFICIAL PROPAGATION OF ASPEN.] Nauch. Tr. Kazakhsk. S.-kh. Inst. 14 (2): 89-100. [Ru. From abstr. in Referat. Zh. 1972 (3.56.163). Ru. NLL]
For root cuttings, results were best with cuttings 30-100 cm long, diameter 1-3 cm, taken and planted in early spring and covered to a depth of 7-10 cm on clay-loams or 12-14 cm on sandy loams, without compaction of the soil after planting.

Janson, L. 1967. [EFFECT OF ENVIRONMENTAL CONDITIONS ON THE REGENERATION OF VEGETATIVE ORGANS IN POPLARS OF SECTION LEUCE.] Prace Inst. Bad. Lesn. No. 328, (3-99). [60 refs. [Pol.ru.g.].]

Kolevska-Pletikapic, B. 1967. [EFFECT OF GROWTH SUBSTANCES AND ANATOMICAL STRUCTURE ON THE ROOTING OF SALIX CAPREA AND POPULUS TREMULA.] Acta bot. croat. No. 26/27, (191-211). [Serb.g. From abstr. in Referat. Z. 1970 (10.56.203). Ru. N.L.L.]

Lattke, H. 1970. [MIST-SPRAY PROPAGATION OF SALICACEAE NOT EASILY GROWN FROM CUTTINGS: NEW RESULTS.] Sozial. Forstw. 20 (6): 172-3, 181. [G.]
Reports: quicker rooting of green cuttings of Populus X canescens, P. tremula and Salix caprea in a rooting medium electrically heated to 24° C.; use of 'Piatherm' (a foamed ureaformaldehyde polymer) as a rooting medium; and the selection of P. tremula X P. tremuloides clones that are easily rooted as green cuttings.

Lepisto, M. 1972. RESULTS OF PROPAGATION TESTS CONDUCTED WITH CUTTINGS IN 1970. Translation, Environment Canada No. OOENV TR 143, 5 pp. [E., Transl. from Metsa ja Puu (1970) No. 12, 5-7. Fi. Limited distribution]

Rone, V. M. 1968. [THE BEST WAY OF GRAFTING ALDER AND ASPEN.] Lesn. Hoz. (10), (84-5). [Ru.]
For Aspen, apical grafts have proved best.

Ronald, W. G., and Cumming, W. A. 1971. COMPATIBILITY AND GROWTH OF COLUMNAR EUROPEAN ASPEN ON POPLAR ROOTSTOCKS. Combined Proceedings, International Plant Propagators' Society 21, 437-441 [E., 6 ref. EMB]
Two hybrid Poplar selections (Brooks 4 and Brooks 6) were promising as regards rooting ability, compatibility and growth. P. tremuloides proved compatible, but its usefulness is limited by a tendency to sucker and by seedling variation.

Schrock, O. 1965. [THE LARGE-SCALE PROPAGATION OF POPULUS TREMULA, P. CANESCENS AND ROBINIA PSEUDOACACIA.] Sozial. Forstw., Berl. 15 (3): 89-93, 96. 17 refs. [G.g.e.]
Describes E. German trials in the large-scale production of planting stock, including the selection of suitable mother trees and cultivated clones, using chiefly root cuttings or suckers. Some clones of P. canescens or P. canescens X P. alba could be propagated satisfactorily by shoot cuttings.

Smilga, J. 1970. [GROWTH AND MORPHOLOGY OF GENERATIVE PROGENY OF ASPEN.] Jaunakais Mezsaimnieciba 12: 3-17 [Lav.]

Smilga, J. 1971. [GENETIC DIFFERENCES IN THE GROWTH AND MORPHOLOGY OF 1-YEAR GRAFTED ASPEN CLONES.] Jaunakais Mezsaimnieciba, Riga No. 13, (23-35) [Lav.ru.de., 5 ref.]
Describes investigations in Latvia on the variation in height, leaf dimensions, stomatal size, and wood density of grafted clones, with special reference to the effect of the root stocks.

Winton, L. 1971. TISSUE CULTURE PROPAGATION OF EUROPEAN ASPEN. For. Sci. 17 (3): 348-50. [6 refs.]

232.329

Igaunis, G. A. 1974. [GROWING PLANTING STOCK IN PLASTIC GREENHOUSES.] Moscow, USSR; Lesnaya Promyshlennost'. 23(pp. [Ru., 83 ref. BLL]
A practical manual of information on the production of planting stock in plastic greenhouses, based on experience in Latvia since the mid 1960s.

Keller, T. 1965. [MODEL [NURSERY] TRIALS WITH FERTILIZERS FOR PLANTS RAISED FOR PLANTING IN CONTAINERS.] Schweiz. Z. Forstw. 116 (3), (243-55). 12 refs. [G.f.]
Results for Aspen indicated that, with suitable fertilizers, weeding time might be reduced by 1-2 years. In general, slow-acting, organic or semi-organic fertilizers [only commercial names are given for] most] were more suitable than mineral fertilizers, but an addition of 20% compost alone was not sufficient.

Langhammer, A. 1967. [HYBRID ASPEN IN JIFFY-POTS.] Norsk Skogbr. 13 (5): 179. [Nor.] [2 photos. 1 tbl.]

Pospisil, J. 1965. [RAISING HYBRID ASPEN PLANTS IN POLYTHENE BAGS.] Sborn. Vysoke Skoly Zemed., Brno (Rada C) (1), (1-6 + 4 photos). [5 refs. [Cz.ru.e.g.].]
Describes 5-year nursery tests in Czechoslovakia in which perforated polythene bags have been used successfully for raising plants from seed obtained by artificial crossing, emphasizing their advantage over earthenware pots. The bags are either slit open before planting out, or used as planting tubes.

Pospisil, J. 1967. THE REARING OF ASPEN (POPULUS TREMULA L.) IN PLASTIC GREENHOUSES. Acta Univ. Agric. Brno (Fac. Silv.) 36 (3): 235-51. [11 refs. [E.e.cz.ru.cz.].]
Describes the design and construction of the first portable plastic greenhouse (made of polythene stretched over a tubular duralumin frame) to be tested in Czechoslovakia. Use of the polythene greenhouse is extremely promising.

232.43

Pohjonen, V. 1974. [EFFECT OF SPACING ON THE FIRST YEAR YIELD AND HEIGHT GROWTH OF SOME SPECIES GROWN ON SHORT ROTATIONS.] Silva Fennica 8 (2): 115-126 [Fin.e., 12 ref.]
In a trial in N. Finland, seedlings of Alnus incana (a), Populus tremula X P. tremuloides (b), Salix 'Aquatica Gigantea' (c) and S. phylicifolia (d) were planted at various spacings and their weight, yield and height growth were measured at the end of the first year. Initial spacing had the greatest effect on the yield of (c) and least on that of (a).

233 AFFORESTATION

Fuchs, G. 1973. [PERENNIAL LUPINS FOR REFORESTATION AND CARE OF THE LANDSCAPE.] Allgemeine Forstzeitung 84 (2): 43-45. [De.]
Describes revegetation and reforestation trials on difficult spoil mounds and open-cast sites of talcum workings in Styria. Betula pubescens, Salix caprea and Populus tremula failed.

Schlatzer, G. 1970. [RAMBLES IN THE DESERT ARBORETUM.] Dansk Dendrologisk Arsskrift 3 (2): 143-158. [Dan.e., 8 ref.]

236 CARE OF REGENERATION OR PLANTATIONS IN THE INITIAL STAGES OF ESTABLISHMENT

Smirnov, V. V. 1967. [EFFECT OF GIBBERELLIN ON THE ANNUAL AND SEASONAL INCREMENT OF SOME WOODY SPECIES.] Lesoved., Moskva (4), (55-63). [30 refs. [Ru.e.].]
Populus tremula, shoot-length increment was increased and the growing season extended, but the treated shoots were thin with few buds and leaves, and often deformed, and were susceptible to damage by low temperatures in winter.

237 AMELIORATION OF FOREST SITES

Haritonov, G. A. 1970. [IMPORTANCE OF THE APPLICATION OF LIME AND GYPSUM IN PLANTATIONS IN THE [SOVIET] CARPATHIANS.] Lesn. Z. 13 (4): 5-7 + 1 tbl. [Ru., 1 ref.]
In trials in which limestone or gypsum were applied on the forest floor in pole stands, limestone at 3 tons/ha. caused a significant improvement after one year in the diameter increment of Populus tremula. Gypsum at 400 kg./ha. increased increment significantly in P. tremula.

Holmen, H. 1973. [FOREST FERTILIZING IN SWEDEN 1972.] Kungliga Skogs- och Lantbruksakadamiens Tidskrift 112 (1/2): 24-28. [Sv.e., EMB]

Langhammer, A. 1971. [A PRELIMINARY FERTILIZER TRIAL IN ASPEN FOREST.] Skogeieren (11), (20-1). [Nor.]
A dense stand of Aspen [Populus tremula] (mean height 17·5 m, mean diameter 16·4 cm, and age 54 years) on an acid sandy site (Aspen site class IV) was treated with 50 kg NPK fertilizer per hectare in 1962 and with 35 kg calcium ammonium nitrate per hectare in 1964. Measurements in 1968 and 1969 showed that the trees responded rapidly in ring width to the first treatment, but that the response declined soon after the second.

Lavricenko, V. M. 1968. [DETERMINING THE FERTILIZER REQUIREMENTS OF FORESTS.] Lesn. Hoz. (8), (41-3). [Ru.]
The annual requirement of N, P, and K (in kg./ha.) by various stand types at various ages is shown.

Saloniemi, M. 1965. [EXPERIENCE IN THE CULTIVATION AND FERTILIZER TREATMENT OF HYBRID ASPEN.] Metsat. Aikak. 82 (4): 136, 156-8. 7 refs. [Fin.e.]
In fertilizer trials, N favoured the growth of seedlings, but P and K had no clear effect. Susceptibility to Valsa nivea and Stilpnotia salicis is also discussed.

24 TENDING OF STANDS AND TREES

242 THINNINGS

Barneoud, C., and Dubois, J. M. 1973. [THINNING YOUNG COPPICE STANDS IN NORTH-EASTERN FRANCE.] In Rapport Annuel, Association Foret-Cellulose 1972, 177-216 [F.e.de., 2 ref.]
Measurements of girth and b.a. in 1972 showed that, to ensure a satisfactory response, stands of this type must be thinned when 10-15 years old, and that 7 m apart is the maximum permissible spacing between felled strips.

Barneoud, C., and Dubois, J. M. 1971. [TWO THINNING TRIALS ON HORNBEAM COPPICE IN NORTH-EASTERN FRANCE. VOLUME TABLES.] Rapp. Ass. For.-Cell. (279-315). [F.e.de.]
Describes a study of the effects of different thinning treatments on the growth of, and yield of pulpwood from, two Carpinus betulus/Populus tremula coppice stands, (a) 40 years old and (b) 18 years old, on similar sites in Aube.

Davydov, A. V. 1971. [TENDING FELLINGS.] Izdatel'stvo Lesnaya Promyshlennost', Moscow, pp. 181. [Ru., NLL]
Details are given of the effect of thinnings on stand yield, stem form, wood quality, and wind and snow resistance.

Koncevoj, P. J. 1968. [THE EFFECT OF TENDING FELLINGS (CLEANINGS AND THINNINGS) ON PHOTOSYNTHETIC PRODUCTIVITY IN ASPEN.] Lesn. Z., Arhangel'sk 11 (5): 45-7. [5 refs. [Ru.].]

243 OPENING OF THE CANOPY (INCREMENT FELLINGS, OVERHEAD RELEASE AND IMPROVEMENT FELLINGS)

Eglite, A. K., and Spalvin's. Z. P. 1964. [RELEASING [CONIFERS IN] YOUNG STANDS BY BARK TREATMENT [OF HARDWOODS] WITH ARBORICIDES.] Lesn. Hoz. 17 (2): 23-4. [Ru.]
In Latvia, the best way of releasing young conifers from Aspen and Birch has been found to be basal application of a 3% solution of butyl ester of 2,4-D or 2,4,5-T in diesel oil from April to late June.

Lindeman, G. V., and Turundaevskaja, T. M. 1970. [THE DYING OF GIRDLED ASPEN TREES AND THE DEVELOPMENT OF PESTS AND DISEASES ON THEM.] In Vzaimootnosenija Komponentov Biogeocenoza v Listvennyh Molodnjakah. Izdatel'stvo 'Nauka', Moscow, pp. 270-81. [Ru., 12 refs.]

Martynov, A. N. 1964. [MICROCLIMATE IN YOUNG MIXED STANDS AFTER CHEMICAL TREATMENT.] Lesn. Hoz. 17 (10): 17-20. [Ru.]
Tabulates data on the microclimatic changes brought about by aerial spraying of butyl ester of 2,4,5-T at 1-3 kg./ha. to release Spruce and Pine under Aspen and Birch in the Leningrad region.

Pauljukevicus, G. B. 1964. [CHANGE IN CLIMATIC FACTORS AFTER SHELTERWOOD FELLING.] Lesn. Hoz. 17 (10): 15-6. [Ru.]
Light, air temperature, soil temperature, precipitation reaching the ground, and Spruce increment all increased, and relative humidity decreased, with increasing intensity of felling, as compared with control plots. Indications are that the best felling is one removing 40-45% of standing volume.

Samgin, P. A. 1965. [BASAL TREATMENT OF [UNWANTED SPECIES IN] YOUNG STANDS.] Lesn. Hoz. 18 (5): 17-9. [Ru.]
In the Leningrad region, tests on basal application with spray or brush of solutions of 2,4-D or 2,4,5-T butyl esters in diesel oil showed that Aspen was more readily killed than Birch, and that 2,4,5-T butyl ester was the more effective of the two arboricides.

Sannikov, G. P., and Tykvina, A. F. 1971. [DESTROYING UNDESIRABLE WOODY VEGETATION BY BASAL TREATMENT WITH ARBORICIDES.] Khimiya u Sel'skom Khozyaistve 9 (12): 37-39. [Ru., 13 ref.] From Weed Abstracts 21, 2362. OW.
Aspen up to ca. 10 cm basal diameter were successfully controlled by painting the bases of the stems with 2 to 4% solutions of the butyl esters of 2,4-D or 2,4,5-T in diesel fuel oil in the first half of the growing season.

245 TENDING OF TREES

Anonymous. 1971. [PRUNING.] Allg. Forstzeitschr. 26 (12): 236-9. [G., 1 ref.]
Includes pruning trials on Birch and Aspen in Norway.

Ibel, K. 1971. POSITIVE ERGEBNISSE AUS ASTUNGSVERSUCHEN AN BIRKE UND ASPE IN NORWEGEN. Allgem. Forstz., Munchen 26 (12): S.239. [dt. Zsfg.]

Poluboyarinov, O. I. 1972. [CHEMICAL PRUNING.] Lesnoe Khozyaistvo No. 8, 25-26 [Ru.]
The lower living branches of young Aspen were sprayed or brushed with 0.5% and 1% solutions of butyl ester of 2,4,5-T and 2,4-D in diesel oil. Further trials were made in August 1969 on 16-year-old Aspen with a 0.5% solution of 2,4,5-T in diesel oil. Inspection of the trees a year later showed that the treated branches had died, that 93% of the trees were normal or satisfactory, and that the others (all weakly or poorly developed before treatment) were dead.

Zumer, M. 1966. [PRUNING STUDIES ON PINE, SPRUCE, BIRCH, ASPEN, ASH AND OAK.] Medd. Norske Skogforsoksv. 20 (6), No. 77, (399-581). 73 refs. [G.nor.]
Birch and Aspen both showed discoloration and decay resulting from pruning, amounts increasing with reduction of crown size and increasing size of branches removed.

Zumer, M. 1968. [DISCOLORATION OF THE WOOD OF SOME SPECIES AFTER GREEN PRUNING.] Norsk Skogbr. 14 (18): 405-6. [6 refs. [Nor.].]
Discusses the distribution of wood discoloration after pruning Aspen and Birch [cf. F.A. 27 No. 5958], and Pagony's theory of

false and wound heartwood and his recommendations on date and techniques for pruning Poplar.

26 COMBINATIONS OF FORESTRY WITH AGRICULTURE

268 PASTURED FORESTS. GRAZING ON FOREST AND OPEN RANGES

Kataev, O. A., Martynov, E. N., Bogdan, M. A., and Sannikov, G. P. 1973. [THE EFFECT OF DYBAR, USED FOR THE CHEMICAL CLEARING OF OVERGROWN PASTURES, ON THE VEGETATION AND ON FOREST INHABITANTS.] Khimiya v Sel'skom Khozyaistve 11 (12): 922-927. [Ru.] From Weed Abstracts 23, 2519. OW.
Trials of Dybar (fenuron granular 25%) were made in 1965-71 [near Leningrad] on medium and heavy, weakly podzolized silty-loam soils for the reclamation of forested areas for agricultural use. The main tree species were Alnus glutinosa, Betula alba, Populus tremula, Prunus padus. Fenuron at 60-90 a.i./ha, applied in spring, summer or autumn over-all or in small areas, gave 97-100% kill of the trees and brush; 30 kg/ha was inadequate and the results suggest that 40-50 kg/ha would be the optimum.

Sannikov, G. P. 1970. [RESULTS OF TESTING GRANULAR ARBORICIDES.] Khimiya v Sel'skom Khozyaistve 8 (4): 289-291 [Ru., 10 ref.] From weed Abstracts 21, 817. OW.

28 HUSBANDRY, GROWING AND COLLECTION, OF FOREST PRODUCTS OTHER THAN WOOD

Grom, I. I. 1967. [THE YIELD OF WILD BERRYBEARING PLANTS IN THE NORTHERN REGIONS OF THE KOMI A.S.S.R.] Rast. Resursy, Moskva 3 (2): 193-8. [5 refs. [Ru.ru.] N.L.L.]
Tabulates data on yields of some 11 species of berries in 5 Pine and 5 Spruce forest types, Birch forests, Aspen forests, bogs, and old felled areas.

Siren, G., Blomback, B. and Alden, T. 1970. PROTEINS IN FOREST TREE LEAVES. Rapp. Uppsats. Instn. Skogsforyngr Skogshogsk. No. 28, pp. 22. [E.sw., 20 ref.]
A test on P. tremula showed that the content of protein declined slightly with increasing leaf age, but its composition remained fairly constant.

3 WORK SCIENCE. HARVESTING OF WOOD: LOGGING AND TRANSPORT. FOREST ENGINEERING

30 WORK SCIENCE (WORK STUDIES): GENERAL

Belin, L. 1972. [IMMUNOLOGICAL ANALYSIS OF BIRCH POLLEN ANTIGENS, WITH SPECIAL REFERENCE TO THE ALLERGENIC COMPONENTS.] International Archives of Allergy 42, 300-322 From Berichte Biochemie und Biologie (1973) 385, 355. De. Reinbek.
The allergenic thermo-stable antigens of Birch pollen can also be found in part in Alder pollen, and to a smaller extent in the pollen of Aspen and Hazel, and in the Hazelnut.

32 FELLING AND RELATED OPERATIONS

Zaharenkov, F. E. 1964. [SOME RELATIONSHIPS OF THE PROCESS OF TRIMMING OFF BRANCHES WITH POWERED TOOLS.] Lesn. Z., Arhangel'sk 7 (2): 70-5. 6 refs. [Ru.]

Pavlenko, F. A. 1973. [SMALL WOOD AS AN INDUSTRIAL RAW MATERIAL.] Lesnoe Khozyaistvo No. 2, 73-76 [Ru.]

37 TRANSPORT

372/377

Grubov, S. 1964. [MEAN VALUES OF THE COEFFICIENTS OF RESISTANCE OF REST BEFORE SLIDING AND ROLLING OF UNBARKED FRESHLY FELLED LOGS ON DIFFERENT MATERIALS.] Lesn. Prom. (6), (32), [Ru.]
Tabulates values of the angles and coefficients of resistance of sliding and rolling of Spruce, Birch, Pine and Aspen logs on logs, boards, ice, iron, zinc, greased iron, brass, etc.

4 FOREST INJURIES AND PROTECTION

42 INJURIES FROM INORGANIC AGENCIES (EXCLUDING FIRE)

Kazadaev, S. A. 1974. [THE EFFECT OF THE DROUGHT OF 1972 ON THE DIAMETER INCREMENT OF TREES IN THE CENTRAL FOREST-STEPPE.] Lesovedenie No. 3, 92-94 [Ru.e.]
P. tremula was the species most severely affected, with a mean decrease in diameter increment of 41%.

Acatay, A. 1968. [SMOKE DAMAGE FROM THE COPPER-SMELTING WORKS IN MURGUL.] Istanbul Univ. Orm. Fak. Derg. 18A (1): 1-17. [4 refs. [Turk.g.g.].]

Pollanschutz, J. 1969. [SUSCEPTIBILITY OF TREE SPECIES TO SO_2 AND HF FUMES AND MAGNESITE DUST.] In Air pollution. Centre for Agricultural Publishing and Documentation, Wageningen. pp. 371-7. [G.e.f., 5 refs.]

Sundstrom, E. W. 1973. [LICHEN DENSITY ON BARK OF POPULUS TREMULA AFFECTED BY INDUSTRIAL SMOKE EMISSION.] Svensk Botanisk Tidskrift 67 (4): 459-461. [Sv.e., 1 ref. OBD]
Reports a study in central Gastrikland (Sweden) of 500 trees, showing a marked reduction in lichen cover up to 10-15 km from the sources of emission. No difference in sensitivity between the most common lichens was noted. Lichens on other tree species were less sensitive to the smoke.

43 FOREST FIRES

Missbach, K. 1967. [SUITABILITY OF IMPORTANT FOREST TREE SPECIES FOR FIREBREAKS AND FIRE-BELTS.] Arch. Forstw. 16 (11): 1173-86. [G.g.ru.e.]

44 DAMAGE BY HARMFUL PLANTS. VIRUS DISEASES

441 FOREST WEEDS

Barring, U. 1965. [TREATMENT OF BROADLEAVED TREE VEGETATION WITH HERBICIDES.] Studia for. suec. Skogshogsk., Stockh. No. 25, pp. 65. Many refs. [Sw.e.e.]
No treatment prevented suckering of Aspen.

Eliasson, L. 1965. INTERFERENCE OF THE TRANSPIRATION STREAM WITH THE BASIPETAL TRANSLOCATION OF LEAF-APPLIED CHLOROPHENOXY HERBICIDES IN ASPEN (POPULUS TREMULA L.). Physiol. Plant., Copenhagen 18 (2): 506-15. 17 refs. [E.e.]
Results showed that the basipetal translocation of 2,4-D and 2,4,5-T occurs in the phloem, but that they are easily transferred from phloem to xylem, where they are carried in the acropetal direction with the transpiration stream. This is thought to be an important factor in chemical control of Aspen, since it limits translocation of herbicides to the roots.

Eliasson, L. 1966. [SUPPLYING HERBICIDE TO THE LOWER PARTS OF THE PLANT WHEN APPLYING FOLIAGE SPRAYS TO ASPEN.] Sveriges SkogsvForb. Tidskr. 64 (5): 429-39. [12 refs. [Sw.e.].]
It is concluded that direct supply of weedkillers to lower parts of the stem and to the roots from outside, as distinct from internal translocation, may be important in the control of sprouting.

Eliasson, L. 1972. RESPONSES OF POPULUS TREMULA TC PICLORAM AND OTHER TRANSLOCATED HERBICIDES. Physiologia Plantarum 27 (2): 101-104. [E., 13 ref.]
Whole plants and isolated root segments were 3-10 times more sensitive to picloram than to 2,4-D, 2,4,5-T or dicamba. Picloram was rapidly translocated from roots to growing shoots, and dicamba from mature leaves to roots. When applied to leaves, picloram, 2,4-D and 2,4,5-T affected roots more slowly. Dicamba, 2,4-D and 2,4,5-T rapidly killed the directly treated leaf tissue, whereas picloram did not.

Eliasson, L. 1973. TRANSLOCATION AND PERSISTENCE OF 2,4-D (2,4-DICHLOROPHENOXYACETIC ACID) IN POPULUS TREMULA L. Weed Res. 13 (2): 140-147. Ref.

Eliasson, L., and Hallmen, U. 1973. TRANSLOCATION AND METABOLISM OF PICLORAM AND 2,4-D IN POPULUS TREMULA. Physiologia Plantarum 28 (1): 182-187. [E., 23 ref.]

Fiedler, H. J., Hulse, R., and Hoffmann, F. 1967. [THE SENSITIVITY OF SEVERAL TREE SPECIES TO ANFORSTAN.] Arch. Forstw. 16 (6/9): 605-8. [4 refs. [G.].]
Species tested were sensitive to chlorate damage in the following (increasing) order: Larix decidua, Alnus glutinosa, Carpinus betulus, Picea abies, Populus tremula, Quercus robur s.l. and Pinus sylvestris.

Fiedler, H., Hulse, R., and Hoffmann, F. 1969. [DECOMPOSITION AND LEACHING OF ANFORSTAN IN A PSEUDO-GLEY.] Arch. Forstw. 18 (1): 31-5. [5 refs. [G.g.ru.e.].]
In trial plantings of Oak, Aspen, Alder, Hornbeam, Larch and Norway Spruce in April there were no after-effects, and growth was better than on weed-infested controls.

Huraux, M. J. 1970. BRUSH CONTROL WITH PICLORAM IN FORESTRY AND ALONG RIGHTS-OF-WAY. Summary Papers, 7th International Congress on Plant Protection, Paris (327-9). [From abstr. in Weed Abstr. (1971) 20 (5): No. 2154. OW]

Il'in, A. M. 1964. [INJECTION OF 2,4-D BUTYL ESTER – AN EFFECTIVE METHOD OF CONTROLLING ASPEN REGENERATION.] Lesn. Z., Arhangel'sk 7 (6): 41-3. 1 ref. [Ru.]
The best results were obtained with the 10% (vs. 5%) solution applied to complete girdles. Study of the wood of dead trees 14 months after treatment shows that the mechanical properties were not significantly different from those of untreated trees.

Kljucnikov, L. Ju., and Bagaeva, M. V. 1969. [PHYSIOLOGICAL REACTIONS OF CONIFERS TO TREAMENT WITH 2,4-D IN YOUNG MIXED STANDS.] Fiziol. Rast. 16 (3): 443-6. [2 refs. [Ru.e.] A.P.B.]
The rate of photosynthesis of the conifers fell temporarily, but this caused no permanent harm, whereas in the broadleaved species the rate of photosynthesis, respiration and transpiration were irreversibly depressed, with consequent death or severe damage.

Nekrasova, G. N., and Poluboyarinov, O. I. 1974. [CHANGES IN SOME INDICES OF THE VIABILITY OF THE PARENCHYMA CELLS OF BIRCH AND ASPEN WOOD IN THE PROCESS OF DYING-OFF [AFTER TREATMENT WITH ARBORICIDES].] Botanicheskii Zhurnal 59 (5): 672-680 + 1 pl. [Ru., 29 ref.]

Poluboyarinov, O. I., Nekrasova, G. N., and Sannikov, G. P. 1972. [THE QUALITY OF WOOD FROM [TREES KILLED BY] ARBORICIDES IN RELATION TO ITS POSSIBLE UTILIZATION.] Lesnoi Zhurnal 15 (3): 18-22. [Ru., 2 ref.]
Aspen wood did not deteriorate as rapidly as Birch after arboricide treatment. In general, the decisive factor governing the utilization of Birch and Aspen 15 months after treatment would not be the deterioration in the mechanical properties of the wood but the development of stains and, to a less extent, decay.

Poluboyarinov, O. I., and Nekrasova, G. N. 1974. [EFFECT OF BASAL TREATMENT WITH 2,4,5-T ON THE VIABILITY OF THE PARENCHYMA CELLS OF WOOD.] Lesnoi Zhurnal 17 (1): 7-11. [Ru., 13 ref.]
Dying cells retained a quite high osmotic pressure, and this is probably associated with the considerable increase in the moisture content of the sapwood of the treated trees.

Kummukainen, U. 1972. [ON THE USE OF BRUSH- AND WEED-KILLERS ON FOREST REGENERATION SITES IN FINLAND IN 1969-70.] Folia Forestalia, Institutum Forestale Fenniae No. 136, 38 pp. [Fin.e., 47 ref.]

Samgin, P. A., and Sutov, I. V. 1964. [TESTING NEW ARBORICIDES.] Lesn. Hoz. 17 (5): 5-7. [Ru.]

Sannikov, G. P. 1970. [ELIMINATION OF BRUSH IN DRAINAGE CHANNELS WITH DYBAR [FENURON].] Khimiya v Sel'skom Khozyaistve 8 (12): 926-928 [Ru., 10 ref.] From Weed Abstracts 21,818. OW.
Granular fenuron (as Dybar) was applied at the end of May 1967 to drainage ditches on sandy loam soils overgrown with Pine, Alder, Birch, Aspen and Willow; 95-100% of trees of the first four species were killed.

Sutov, I. V., et al. 1964. [CHEMICAL METHODS OF DESTROYING WEED SHRUBS AND TREES.] Izdatel'stvo 'Kolos', Moscow. pp. 216. 9 pp. of refs. [Ru.] N.L.L.

Voevodin, A. V. [Compiler]. 1964. [HERBICIDES.] Izdatel'stvo 'Kolos', Leningrad. pp. 320. Many refs. [Ru.] O.W.

443 FUNGI AND BACTERIA

Alekseev, V. A. 1971. [ESTIMATING THE DEGREE OF DAMAGE TO POPULUS TREMULA BY FOMES TREMULAE IN RELATION TO THE CONTENT OF METABOLIZED CALCIUM AND MAGNESIUM IN THE SOIL.] Les. Zh. 3: 7-9 [Ru.]

Durrieu, G. 1967. [NOTE ON THE EPIDEMIOLOGY OF MELAMPSORA PINITORQUA.] Trav. Lab. For. Toulouse tome 6, vol. 4, art. 2, pp. 8. [10 refs. [F.] 1 gph.]
A study of a seedling stand of Pinus pinaster, infected from regrowth of Populus tremula clumps that had been felled before the Pine was sown. Seedlings within 100 m. of clumps were infected in the first 3-4 years. After that they appeared to be more or less immune.

443.3

Alekseev, V. A. 1969. [EFFECT OF SPRUCE AND BIRCH ON ROT DEFECT IN ASPEN.] Lesn. Z., Arhangel'sk 12 (2): 154-5. [Ru.]
In stands containing 20-40% Birch, the quality of Aspen was good, whereas in stands with over 50% Birch it declined. The presence of up to 20% Spruce in the top storey did not affect quality of Aspen, but a second storey of Spruce had an adverse effect.

Bobrov, R. V. 1964. [DETERMINING THE SUSCEPTIBILITY OF ASPEN TO ROT.] Lesn. Hoz. 17 (8): 21-5. [Ru.]
An analysis of stain and rot caused by Fomes igniarius in 301 Aspen stems from stands 25-30 years old, of varying composition and density, in the Leningrad region.

Bol'shova, N. I. 1971. [CHANGES IN THE CELL-WALL THICKNESS AND FIBER LENGTH OF ASPEN WOOD INFECTED WITH THE FUNGUS PHELLINUS TREMULAE (BOND.) BOND. ET BORISS., IN CONNECTION WITH CHANGES IN ITS DENSITY.] Sb. Tr. TNII Bumagi No. 6, 26-31, 203 [Ru.e.] From Abstract Bulletin of the Institute of Paper Chemistry 43, 4177(U). LTP.

Bratus', V. M., and Ciljurik, A. V. 1964. [PHELLINUS TREMULAE ON DARK- AND GREEN-BARKED FORMS OF ASPEN.] Ukr. bot. Z. 21 (1): 90-7. 10 refs. [Ukr.ru.e.] A.P.B.

Bratus', V. M., and Cyljuryk, A. V. 1968. [ANATOMICAL FACTORS IN THE RESISTANCE OF THE GREEN-BARKED FORM OF ASPEN TO PHELLINUS TREMULAE.] Ukr. bot. Z. 25 (4): 65-72. [14 refs. [Ukr.ru.e.] A.P.B.]
The greater resistance of the wood of the green-barked form was found to be due to the considerably thicker cell-walls of the libriform fibres and vessels, the lower air content, and the smaller proportion of rays.

Bratus', V. M., and Tsilyurik [Cyljuryk], A. V. 1969. ANATOM-

ICAL FACTORS OF RESISTANCE IN GREEN-BARK ASPEN TO FALSE SPONK (PHELLINUS TREMULAE (BOND.) BOND. ET BORISS). Transl. Dep. Fish. For. Can. No. OOFF-25, pp. 9. [14 refs. Transl. from Ukr. bot. Z. 1968, 25 (4): 65-72.

Ciljurik, A. V. 1968. [THE RESISTANCE OF WOOD OF THE GREEN-BARKED AND DARK-BARKED FORMS OF ASPEN TO PHELLINUS TREMULAE IN ARTIFICIAL CONDITIONS.] Ukr. bot. Z. 25 (1): 29-34. [15 refs. [Ukr.ru.e.] A.P.B.]
In laboratory experiments, the P. [Fomes igniarius f.] tremulae strain isolated from the green-barked form of Aspen was much more destructive to the wood of both forms of Aspen than that isolated from the dark-barked form. Wood sampled from heights of 1·3-9 m. in both Aspen forms was more vulnerable to attack than stump-wood or wood sampled from a height of 11 m.

Dimitri, L. 1971. [THE RESISTANCE OF SEVERAL POPLAR CLONES OF THE SECTION LEUCE TO POLLACCIA RADIOSA.] Europ. J. For. Path. 1 (1): 18-22. [De.e.f., 14 ref.]
A triploid Populus tremula was highly resistant, and two clones of a 'tremula type' were fairly resistant.

Fedorov, N. I. 1969. [THE WATER REGIME OF ASPEN INFECTED BY HEART ROT.] Nauc. Dokl. Vyss. Skoly (Biol. Nauki), Moskva (9), (95-9). [10 refs. [Ru.ru.] N.L.L.]
Studies on healthy Aspen (Populus tremula) and Aspen attacked by Phellinus tremulae indicated that the development of heart rot is accompanied by a great increase in the moisture content of the affected wood. Heart rot tends to reduce the m.c. of the sapwood, the total m.c. of the leaves and shoots, and the transpiration rate.

Fyodorov, N. I. [Fedorov, N. I.] 1973. ASPEN HEART ROT IN THE FORESTS OF BYELORUSSIA. In Abstracts of Papers, 2nd International Congress of Plant Pathology, Minneapolis. 0416. [E.]

Guscin, I. I. 1969. [FEATURES OF THE INITIATION AND SPREAD OF HEART ROT IN ASPEN STEMS.] Lesn. Z. 12 (6): 163-5. [Ru.]
Analyses the kinds of injuries that affect 1-year suckers, and the rate of spread of stain and decay in Populus tremula trees of various classes up to 45 years.

Hanso, M., and Tamm, U. 1973. [POLLACCIA RADIOSA, A NEW DISEASE ON ASPEN LEAVES AND TWIGS IN EASTERN ESTONIA.] Metsanduslikus Uurimused 10, 282-290. [Ee.ru.e., 13 ref.]
In 1970 P. radiosa (Venturia tremulae) was observed causing widespread damage on Populus tremula. The only previous record of P. radiosa in Estonia was on leaves of Populus alba in 1935.

Hinds, T. E. 1964. DISTRIBUTION OF ASPEN CANKERS IN COLORADO. Plant Dis. Reptr. 48 (8): 610-4. 9 refs.

Il'in, A. M. 1973. [THE RESISTANCE OF MALE AND FEMALE ASPEN TO PHELLINUS TREMULAE.] Mikologiya i Fitopatologiya 7 (4): 344-347. [Ru., 15 ref., NLL]
Results revealed no significant difference between ♂ and ♀ Aspen in the resistance of (dead) wood to stem rot, despite the numerous field observations by Russian authors that ♀ trees are more resistant.

Kallio, T. 1972. [DECAY IN A TEN-YEAR-OLD STAND OF HYBRID ASPEN.] Silva fenn. 6 (1): 1-13. [Fi.e., 35 ref.]
In all cases decay was present, reaching from an affected branch down the stem to ca. 20-30 cm below the felling point. Culturing of wood samples from infected stems showed that bacteria were much more frequent than fungi, and that ca. 48% of the isolated bacterial strains were cellulolytic. No basidiomycetes were found among the fungi isolated from discoloured stemwood.

Kostylev, A. S. 1972. [THE EFFECT OF LIGHT ON THE GROWTH AND INFECTION OF ASPEN BY PHELLINUS TREMULAE.] Lesnoi Zhurnal 15 (4): 31-35. [Ru., 8 ref.]
Compares the growth and health of Populus tremula aged 37 years in the middle of a pure Aspen stand, i.e. in shady conditions, and at the margin, i.e. in good light. Growth and self-pruning were better, and the proportion of trees with fungus fruiting bodies was smaller, at the margin.

Kostylev, A. S., and Emel'janov, V. D. 1968. [VARIATION IN THE VOLUME OF HEART ROT IN ASPEN WITH AGE OF THE TREE.] Lesn. Z., Arhangel'sk 11 (3): 144-6. [5 refs. [Ru.].]
Briefly discusses graphical data on the pattern of attack by heart rot in Populus tremula, obtained from studies of the proportion and distribution of decayed wood in sample stems from the Leningrad, Smolensk and Kalinin regions. To ensure the maximum yield of sound wood, felling at 41-50 years is recommended.

Kotlaba, F., and Pouzar, Z. 1968. SOME NEW DATA ON FOMES TREMULAE. Ceska Mykologie, Praha 22 (4): 279-95. [[Cz.e.] From abstr. in Rev. appl. Mycol. 1969 48 (2): 112.]
Describes and regards as a distinct species F. tremulae, previously described as Phellinus [F.] igniarius f.sp. tremulae and P. [F.] nigricans var. populinus.

Kurkela, T. 1973. EPIPHYTOLOGY OF MELAMPSORA RUSTS OF SCOTS PINE (PINUS SYLVESTRIS L.) AND ASPEN (POPULUS TREMULA L.). Metsantutkimuslaitoksen Julkaisuja 79 (4): 68 pp. [E.fi., 6 1/2 pp. of ref.]

Kurkela, T. 1969. [LEAF RUST ON ASPEN IN FINNISH LAPLAND.] Folia for. Inst. For. Fenn. No. 64, pp. 4. [7 ref. [Fi.e.].]
The frequency of Melampsora pinitorqua, sampled on leaves of Populus tremula collected between latitudes 67° and 70° N., was closely related to the average accumulated temperature of the growing season, being greatly reduced where this was ≯ 700-750 degree-days.

Langhammer, A. 1971. NEOFABRAEA POPULI IN PLANTATIONS OF HYBRID ASPEN IN NORWAY. Meddeleser fra det Norske Skogforsoksvesen 29 (114): 281-291. [E.nor., 3 ref.]
Most of the attacks occurred at 2-3 m above ground level, just below the lower branches of the crown on the north side of the tree. In some trees the cambium was dead all round the stem, and such trees were sometimes broken at the point of attack. No significant difference was found between trees representing different crosses. Some trees of pure P. tremula were also attacked.

Lohwag, K. 1969. [PHELLINUS TREMULAE.] Allg. Forstztg. 80 (6): 133-4. [9 refs. [G.].]
Reports the identification of P. tremulae (presumably hitherto confused with P. (Fomes) igniarius) on Aspen in Austria.'

Longo, N., and Naldini, B. 1972. [OBSERVATIONS ON THE ULTRASTRUCTURE OF THE HAUSTORIUM OF MELAMPSORA PINTORQUA IN POPULUS TREMULA CELLS.] Caryologia 25 (3): 383-401. [It.e.] From Review of Plant Pathology 52, 1282.

Mirosnikov, V. S., and Fedorov, N. I. 1969. [HEART-ROT DAMAGE TO ASPEN STANDS IN TRANS-BAIKALIA.] Lesn. Z., Arhangel'sk 12 (3): 13-6. [Ru., 3 refs.]

Melnik, V. A. 1965. [PARASITIC FUNGI IMPERFECTI IN CERTAIN FOREST PHYTOCOENOSES OF THE LENINGRAD REGION.] Bot.Z. 50 (7): 981-6. 11 refs. [Ru.] 4 tbls.
Analyses the distribution of these fungi in Birch, Spruce, and Aspen forests by vegetation layers, forest types, etc.

Molotkov, L. K. 1971. [CHANGES IN THE CHEMICAL COMPOSITION OF ASPENWOOD DURING DECAY.] Sb. Tr. VNII Tesllyul.-Bumazh. Prom. No. 58, 231-236. [Ru., 13 ref.] From Abstract Bulletin of the Institute of Paper Chemistry 44, 4058. LTP.
Gives details of the chemical changes in wood of Populus tremula attacked by Phellinus tremulae. The decrease in the contents of cellulose, pentosans, and lignin was proportional to the loss of weight. The solubility of wood in 1% NaOH also decreased proportionally to weight loss. Ash content increased as wood density decreased.

Morelet, M. 1972. [ON THREE LEAF PARASITES OF POPLARS.] Bulletin de la Societe des Sciences Naturelles et d'Archeologie de Toulon et du Var 28 (201): 3-4. [F.] From Review of Plant Pathology 53, 2699.
Describes symptoms and damage caused by Titaesporina tremulae to Populus tremula, 'P. tremuloides and P. trichocarpa in France, with brief notes on Pollaccia balsamiferae and Cladosporium maculicolum.

Morelet, M., and Pinon, J. 1973. [DARLUCA FILUM, A HYPERPARASITE OF THE GENUS MELAMPSORA ON POPLAR AND WILLOW.] Revue Forestiere Francaise 25 (5): 378-379. [F., 8 ref.]

Orekhov, D. A. 1974. [INTERACTION OF FOMES ANNOSUS

/ITH BACTERIA OF THE RHIZOSPHERE OF WOODY LANTS.] Mikologiya i Fitopatologiya 8 (3): 245-249. [Ru., 10 ef. NLL]

armasto, E., and Tamm, U. 1969. [A SERIOUS DISEASE OF .SPEN.] Eesti Loodus. Tartu (9), (520-4). [Est.e.ru., From abstr. n Rev. Plant Path. 1970, 49 (5): 260.]
hellinus [Fomes igniarius f.] tremulae is wide-spread in Estonian orests. In 40-year-old forests, 11-34% of trees of Populus tremula, nd in 130-year forests all trees, have fruit bodies. P. (F.) igniarius is are on Aspen.

:oll-Hansen, F. 1967. PHELLINUS TREMULAE (BOND.) BOND. : BORISS, AND PHELLINUS IGNIARIUS (L. EX FR.) QUEL. ON OPULUS TREMULA L. Medd. Norske Skogforsoksv. 23 (No. 85): 39-63. [17 refs. [E.e.nor.].]
'oncludes that P. [Fomes igniarius f.] tremulae and P. [Fomes] gniarius are seperate species, that P. igniarius on Aspen and P. gniarius f. betulae are conspecific, and that there is probably no lear difference between P. tremulae on green- and dark-barked orms of Aspen in Norway.

:oll-Hansen, F., and Roll-Hansen, H. 1969. NEOFABRAEA OPULI ON POPULUS TREMULA X POPULUS TREMULOIDES N NORWAY: COMPARISON WITH THE CONIDIAL STATE OF IEOFABRACA MALICORTICIS. Medd. Norske Skogforsoksv. 7 (3), No. 98 (219-226). [E.nor., 8 refs.]
)escribes the symptoms of attack and fungal stages of N. populi; his is thought to be its first record outside the U.S.A.

Siwecki, R. 1974. A REVIEW OF STUDIES ON THE OCCURRENCE OF MELAMPSORA PINITORQUA IN CENTRAL AND EASTERN EUROPE. European Journal of Forest Pathology 4 (3): 48-155. [E.de.f., 31 ref.]
Reviews papers on the biology and occurrence of the disease and nethods of control in young plantations of Pinus sylvestris, with articular reference to Poland, where the distribution of the fungus lepends on the presence of the alternate host, Populus tremula.

Solov'ev, A. M. 1973. [THE RESISTANCE OF TREES AND SHRUBS TO FOMES ANNOSUS.] Nauch. Tr. Kazakhsk. NII les. :hva No. 8, 141-144. [Ru.] From Referativnyi Zhurnal (1974) 4.56.66 Ru. NLL.

Solov'ev, V. A. 1967. [SEARCH FOR ANTAGONISTS OF PHELLINUS TREMULAE.] Mikol. i Fitopat., Leningrad 1 (2): 79-82. [13 refs. [Ru.] I.M.I.]

Solov'ev, V. A. 1968. [THE GAS REGIME IN ASPEN STEMS IN RELATION TO THE DEVELOPMENT OF DECAY CAUSED BY PHELLINUS TREMULAE.] Mikol. i Fitopat., Leningrad 2 (3): 233-41. [21 refs. [Ru.] I.M.I.]
Sapwood and rot had the same CO_2/O_2 index (ca. 1), whereas heartwood, ripewood and wetwood had an index > 1. The concentration of CO_2 and O_2 is not the direct cause of the mmunity of the sapwood of the living tree to P. tremulae.

Stepanova, O. A. 1973. [DECOMPOSITION OF WOOD OF DIFFERENT AGES BY BASIDIOMYCETES.] Mikologiya i Fitopatologiya 7 (2): 105-11. [Ru., 15 ref. NII]

Stepanova, O. A. 1973. [FUNGI ON LOGGING RESIDUES IN SPRUCE FORESTS OF THE LENINGRAD REGION. I.] Mikologiya i Fitopatologiya 7 (5): 386-391. [Ru., 5 ref. NLL]

Suvorov, P. A. 1967. BIOLOGICAL CHARACTERISTICS OF FOMES FOMENTARIUS, FOUND ON SPRUCE AND BIRCH. Canad. J. Bot. 45 (10): 1853-7. [9 refs., O.R.S.]
In tests on wood of 9 species, weight losses were greater for the P. abies strain on Pine, Spruce and Oak, and smaller on Birch, Beech, Aspen, Lime and Maple.

Vihrov, V. E., Fedorov, N. L., et al. 1969. [TYPES OF STEM ROTS IN ASPEN, AND THEIR CHARACTERISTICS.] Lesn. Z., Arhangel'sk 12 (2): 11-5. [Ru., 3 refs.]

Weisgerber, H. 1968. [THE IMPORTANCE OF SHOOT BLIGHT [CAUSED BY POLLACCIA RADIOSA] FOR POPLARS OF THE SECTION LEUCE. I.] Holzzucht, Reinbek 22 (1/2): 1-6. [G.g.e.]
Symptoms, development, distribution, in vitro studies on nutrient and humidity requirements of the fungus, and studies on spread of the disease (attacking mainly young plants) are discussed.

Zukov, A. M. 1968. [CYCLES OF DEVELOPMENT OF ROT DEFECTS IN ASPEN FORESTS IN THE NOVOSIBIRSK REGION.] Mikol. i Fitopat., Leningrad 2 (4): 322-3. [Ru., 3 refs., I.M.I.]
Illustrates the process of defect development as a continuous cyclical process in time and space throughout the life of Populus tremula stands.

Zukov, A. M. 1967. [THE MAIN FUNGAL DISEASE OF THE ASPEN AND BIRCH FORESTS OF THE NOVOSIBIRSK REGION.] Mikol. i Fitopat., Leningrad 1 (1): 69-73. [3 refs. [Ru.] 5 tbls.]
Tabulates details of the incidence of disease by the 7 most important species of fungi, by Birch and Aspen age classes in various forest types.

45 DAMAGE BY ANIMALS

451 MAMMALS

Gruzdev, V. V. 1964. [WINTER AND SUMMER FEEDING OF LEPUS EUROPAEUS IN THE S. TRANS-VOLGA REGION.] Zool. Z., Moskva 43 (7): 1089-93. 5 refs. [Ru.e.] B.A.P.

Hansson, L. 1969. SPRING POPULATIONS OF SMALL MAMMALS IN CENTRAL SWEDISH LAPLAND IN 1964-68. Oikos 20 (2): 431-50. [E.ru., 56 refs.]

Klinkspoor, T. H., and Luitjes, J. 1970. [INVESTIGATION ON THE USE OF AUXILIARY SPECIES AS A PROTECTION AGAINST FRAYING BY ROE.] Ned. Bosb. Tijdschr. 42 (10): 247-58. [Du.e., 4 refs.]
Prunus avium, Populus tremula, Sorbus aucuparia, Salix daphnoides and possibly Robinia pseudoacacia were the preferred species.

Lykke, J. 1965. [ELK AND FOREST.] Norsk Skogbr. 11 (5): 151-3. [Nor.]
Species browsed, in descending order of preference, were Juniper, Willow, Rowan, Aspen, Pine and Spruce.

Tatarinov, K. A., and Djakum, F. A. 1969. [REINTRODUCTION OF EUROPEAN BISON IN THE FORESTS OF THE VOLYN REGION.] Zool. Z., Moskva 48 (4): 612-4. [5 refs. [Ru.e.] B.A.P.]
Reports observations mainly on the tree and shrub species browsed and damaged since 1965, when 15 bison were introduced into a varied forest reserve in the Ukraine. Bark damage appears to be worst on Euonymus verrucosus, Populus tremula, Fraxanus excelsior Salix spp., Quercus spp., and Ulmus spp.

453 INSECTS

Englebrecht, L. 1971. CYTOKININ ACTIVITY IN LARVAL INFECTED LEAVES. Biochem. Physiol. Pflanzen 162 (1): 9-27. [E., 20 refs. O.B.D.]
Tissues of leaves of Populus tremula attacked by S. argyropeza were shown to contain greatly increased amounts of cytokinins. In contrast to healthy Birch and Beech, healthy Poplar leaves contained considerable amounts of endogenous cytokinin.

Engelbrecht, L., Orban, U., and Heese, W. 1969. LEAF-MINER CATERPILLARS AND CYTOKININS IN THE 'GREEN ISLANDS' OF AUTUMN LEAVES. Nature, Lond. 223 (5203): 319-31. [4 refs.]
Investigations on larvae of Stigmella argyropeza infesting leaves of Populus tremula showed that under the influence of certain leaf-miners there is a large accumulation of cytokinins round the mines, which may be responsible for the preservation of chlorophyll at a time when the metabolic activity of the plant is declining.

Inoue, M. 1964. [ON THE LIFE HISTROY OF CRYPTARRHYNCHUS LAPATHI LINNE IN HOKKAIDO.] J. Jap. For. Soc. 46 (6): 220-5. 12 refs. [Jap.]

Kolomiets, N. G. 1971. [THE NATURAL ENEMIES OF THE SATIN MOTH IN THE LOWLANDS OF WESTERN SIBERIA.] Izvestiya Sibirskogo Otdeleniya Akademii Nauk SSSR, Biologicheskikh Nauk No. 10 (2): 102-109. [Ru.e., 11 ref.] From Review of Applied Entomology, A 60, 4754.
The most effective parasite was Telenomus nitidulus, others included the tachinids Rogas, Apanteles and Meteorus, in caged larvae from the Tomsk region nearly 80% mortality resulted from a polyhedrosis virus disease.

Loyttyniemi, K. 1972. [INSECT DAMAGE IN HYBRID ASPEN STANDS.] Silva Fennica 6 (3): 187-192. [Fi.e., 15 ref.]
Saperda carcharias and S. populnea proved to be common, occurring respectively in 26% and 36% of the trees examined.

Obozov, A. N. 1968. THE WHITE SATIN MOTH. Zaschita Rastenii 13 (9): 46. [Ru., From Review of Applied Entomology, A 60, 4757.]
Widespread outbreaks of Stilpnotia [Leucoma] salicis on Populus tremula have occurred in the North Caucasus in the last 15 years. Aerosol spraying with 8% technical DDT in diesel oil (AG-Lb) at 10 litres/ha was effective.

Schnaider, Z. 1964. [THE BIONOMICS AND MORPHOLOGY OF AEGERIA MELANOCEPHALA [ON POPULUS TREMULA].] Polski Pismo Entomologiezne, Wroclaw (Ser. B.) (3/4): 203-21. [23 refs. [Pol.e.ru.] From abstr. in Rev. Appl. Ent. (1967) 55A (6): 340.]
Describes the various stages, development, egglaying, larval behaviour, damage to the wood, and predation by woodpeckers.

Strojny, W. 1974. [DAMAGES ON THE LEAVES OF POPULUS TREMULA L. CAUSED BY THE ADULTS OF SAPERDA CARCHARIAS (L.) (COLEOPTERA, CERAMBYCIDAE).] Pol. Pismo. Entomol. 44 (1): 231-234. [Pol.e.]

459 OTHER ANIMALS

Loyttyniemi, K., and Tulisalo, U. 1974. ON THE OCCURRENCE OF METATETRANYCHUS ULMI KOCH AND TETRANYCHUS URTICAE KOCH (ACARINA, TETRANYCHIDAE) ON FOREST TREES IN FINLAND. Annales Entomologici Fennici 40 (4): 162-167. [E., 20 ref. OH]
The distribution of these two mites was mapped and the damage caused to the leaves of deciduous trees was evaluated during 1968-73.

46 DAMAGE TO TREE GROWTH BY MAN

Rubtsov, N. I., and Shchedrova, V. I. 1973. [THE DEVELOPMENT OF DECAY IN ROOTS AFTER MECHANICAL DAMAGE.] In Lesovodstvo, lesnye kul'tury i pochvovedenie Vyp. I. Leningrad, USSR; Izdatel'stvo Leningradskogo Universiteta. 114-118. [Ru., BLL]
Fungal penetration, determined annually from 1961 to 1970 on 209 severed roots, was greater in the hardwoods than in the softwoods, but in no case did decay reach the stem.

5 FOREST MENSURATION

52 MEASUREMENTS OF STEM DIMENSIONS AND VOLUME OF TREES, STANDS, FORESTS AND TIMBER

524 DETERMINATION OF THE VOLUME OF TREES AND STANDS

524.1

Golikov, V. V., and Falaleev, E. N. 1966. [PATTERNS IN THE STRUCTURE OF BRANCHES OF SIBERIAN TREE SPECIES.] Lesn. Z., Arhangel'sk 9 (5): 30-2. [4 refs. [Ru.].]

Voichal', P. I. 1974. [GENERAL MATHEMATICAL MODEL OF THE FORM OF A TREE STEM.] Lesnol Zhurnal 17 (6): 23-27. [Ru., 12 ref.]

Zaharov, V. K. 1964. [NORMAL FORM FACTORS.] Lesn. Hoz. 17 (5): 16-8. [Ru.]
Discusses the usefulness, in volume and increment calculations, of the normal form factor, f_n, which has been found by the author to be constant for a given species and not to depend on height or d.b.h.

Zaharov, V. K. 1965. [FORM HEIGHTS OF TREES AND STANDS.] Lesn. Hoz. 18 (9): 26-8. [Ru.]
Discusses the usefulness of form height (H_f) in volume calculations and, on the basis of recent Soviet studies, gives equations for Scots Pine, Norway Spruce, Oak, Birch, Aspen, Siberian Larch, and Alnus glutinosa, expressing the linear relationship between H_f and total height (H).

524.3

Anucin, N. P. 1967. [DETERMINING THE VOLUMES OF TREE-LENGTHS AND ASSORTMENTS.] Izdatel'stvo 'Lesnaja Promyslennost', Moscow. pp. 183. [[Ru.] N.L.L.]
Presents double-entry tables of stem volume o.b. and u.b. for various height classes of Populus tremula. Auxiliary tables are given for determining stand height classes. In addition, log volume tables are given for mid-diameters 6, 7, 8 . . . 70 cm. and lengths 1·0, 1·1, 1·2 . . . 9·5 m.

Burnevskij, J. I. 1966. [METHOD OF CONSTRUCTING [STEM] VOLUME TABLES, AND STAND B.A. AND VOLUME TABLES FOR YOUNG STANDS.] In Sbornik naucno-issledovatel' skih Rabot po Lesnomu Hozjajstvu. Leningradskij Institut Lesnogo Hozjajstva. (10). pp. 38-49. [[Ru.] From abstr. in Referat. Z., Moskva (5.56.181). [Ru.].]

Cihladze, T. G. 1964. [DETERMINING STAND VOLUME AND DENSITY AS A FUNCTION OF BASAL AREA.] Lesn. Hoz. 17 (10): 37-8. [Ru.]
Presents tables of stand volume and density as a function of b.a. and height for Populus tremula.

Dorofeeva, A. A., and Sejngauz, A. S. 1970. [VOLUME TABLES FOR MENSURATION WORK IN YOUNG CONIFER/HARDWOOD STANDS.] Sborn. Trud. Dal'nevost. Nauc.-issled. Inst. Lesn. Hoz. No. 10 (65-75). [Ru., From abstr.' in Referat. Z. 1970. (11.56.202). Ru. N.L.L.]

Eriksson, H. 1973. [VOLUME FUNCTIONS FOR STANDING TREES OF FRAXINUS EXCELSIOR, POPULUS TREMULA, ALNUS GLUTINOSA AND PINUS CONTORTA VAR. LATIFOLIA.] Rapporter och Uppsatser, Institutionen for Skogsproduktion No. 26, 26 pp. [Sv.e., 14 ref.]

Finnish Forest Research Institute. 1969. [THE DECREE OF THE [FINNISH] FOREST RESEARCH INSTITUTE ON CONVERSION FACTORS AND VOLUME TABLES TO BE USED IN TIMBER MEASUREMENT. Folia for. Inst. For. Fenn. No. 57, pp. 242. [Fin.Sv.]

Khazov, P. A. 1972. [VOLUMES OF SMALL STEMS OF THE MAIN FOREST TREE SPECIES IN THE UPLAND OAK FORESTS OF THE SOUTH-CENTRAL FOREST-STEPPE.] Lesnoi Zhurnal 15 (4): 14-17. [Ru., 2 ref.]

Moskalev, A. G., Nahabcev, I. A., and Piscelin, M. I. 1966. [NEW TABLES FOR FOREST INVENTORY.] Lesn. Hoz. 19 (5): 48-51. [Ru.]

Semencenko, N. N. 1965. [A NEW WAY OF DETERMINING STAND VOLUME.] Lesn. Z., Archangel'sk 8 (2): 168-9. 1 ref. [Ru.]

525 VOLUME BY ASSORTMENTS. MERCHANTABLE VOLUME.

Anonymous. 1973. [ASSORTMENT TABLES FOR PINE, SPRUCE, FIR, OAK, BEECH, ASH, MAPLE, HORNBEAM, ASPEN, BIRCH, ALDER, LIME AND ROBINIA.] Kiev, USSR, Budivelnik. 443 pp. [Ru., NLL]

Poljakov, A. V. 1967. [VARIATION IN THE YIELD OF ASSORTMENTS FROM STEMS IN ASPEN STANDS.] Lesn. Z., Arhangelsk 10 (1): 46-9. [Ru.] [1 gph., 2 tbls.]
An analysis based on study of 250 trees aged 35-56 in the Ukraine.

Stoljarov, D. P. 1967. [ASSORTMENT STRUCTURE OF THE WOOD REMOVED IN THINNINGS.] Lesn. Hoz. 20 (3): 25-6. [Ru.] [2 tbls.]

526 LOG MEASUREMENT. "SCALING"

Anonymous. 1971. [WEIGHT-TABLE FOR DETERMINING THE WEIGHT OF A LOAD OF LOGS.] Inform. Skogbr. Skogind. Forskn-Foren. (Transportutv.) No. 188, pp. 7. [Nor.]

Nagoda, L. 1968. [THE WATER CONTENT OF WOOD, AND WEIGHT MEASUREMENT: A STUDY OF LITERATURE.] Tidsskr. Skogbr. 76 (3): 191-216. [64 refs. [Nor.e.].]
It is concluded that green weight alone is inadequate as a basis for measurement but that weighing, with a correction for dry-matter content, gives satisfactory results regardless of species, log size and season.

53 SPECIAL MEASUREMENTS OF TREES AND STANDS (CROWN DIMENSIONS, STAND DENSITY, ETC.)

Cybul'ko, I. S. 1969. [THE CENTRE OF GRAVITY OF TREES OF THE MAIN SPECIES IN NORTH EUROPEAN RUSSIA.] Lesn. Z. 12 (5): 45-9. [Ru., 1 ref.]

Efimov, N. P. 1973. [THE CENTRE OF GRAVITY OF THE AERIAL PART OF TREES.] Lesnoe Khozyaistvo No. 2. 52-53. [Ru.]

Il'in, A. M. 1972. [VOLUMETRIC WEIGHT OF WOOD OF MALE AND FEMALE SPECIMENS OF POPULUS TREMULA DURING THE GROWTH PERIOD.] Les. Zh. 4: 25-27. [Ru.]

Usol'tsev, V. A. 1974. [PHYTOMASS OF THE CROWN OF MATURE BIRCH/ASPEN STANDS IN NORTHERN KAZAKHSTAN.] Lesovedenie No. 2, 86-88. [Ru.e., 16 ref.]

54 ASSESSMENT OF SITE QUALITY

Kozlovskij, V. B., and Stepin, V. V. 1966. [THE NEED FOR NEW SITE-CLASS SCALES.] Lesn. Hoz. 19 (1): 38-41. [Ru.]
Two new site-class scales are constructed: (1) for species that grow rapidly from an early age (Aspen, Alder, Birch, and all coppice stands); and (2) for species that grow slowly at first (conifers and all other broadleaved species of seed origin).

56 INCREMENT; DEVELOPMENT AND STRUCTURE OF STANDS

Langhammer, A. 1969. [AMOUNTS PRODUCED BY VARIOUS NORWEGIAN TREE SPECIES.] Norsk. Skogbr. 15 (2): 41-4. [15 refs. [Nor.].]
Gives tables and graphs showing mean height and mean volume increment at various ages for Aspen, and briefly discusses the results in relation to choice of species.

561 INCREMENT IN HEIGHT, DIAMETER, BASAL AREA

Voinov, G. S. 1974. [THE HEIGHT INCREMENT OF PICEA ABIES BELOW AN ASPEN CANOPY.] Lesnoe Khozyaistvo No. 11, 33-37. [Ru., 11 ref.]

562 VOLUME INCREMENT

Antanaitis, V. V. 1971. [MATHEMATICAL MODELS OF THE CURRENT INCREMENT OF SOME TREE SPECIES.] Lesn. Khoz. (2), (49-52). [Ru.]

566 YIELD TABLES AND THEIR CONSTRUCTION

Burnevskij, J. L. 1969. [A PROVISIONAL YIELD TABLE FOR YOUNG CLOSED MIXED ASPEN STANDS IN THE LENINGRAD REGION.] Lesn. Z. 12 (6): 160-1 + 1 tbl. [Ru., 1 ref.]

Jurkevic, I. D., and Petrovskij, P. J. 1967. [THE ECONOMIC PERFORMANCE OF ASPEN FOREST TYPES IN BELORUSSIA.] Lesn. Z., Arhangel'sk 10 (2): 156-60. [2 refs. [Ru.].]

Kuznecova, V. G. 1965. [YIELD AND ASSORTMENT STRUCTURE OF SPRUCE/FIR STANDS IN THE UDMURT ASSR.] Lesn. Z., Arhangel'sk 8 (6): 48-51. [Ru.]

Mendlik, G. 1967. [YIELD STUDIES IN BEECH STANDS OF ZALA DISTRICT.] Erdesz. Kutatas., Budapest 63 (1/3): 17-28. [7 refs. [Hu.hu.ru.g.].]

Smirnov, V. V. 1970. [YIELD OF CLOSED ASPEN STANDS OF THE AEGOPODIUM/CAREX TYPE IN THE TELLERMAN FOREST.] In Vzaimootnosenija Komponentov Biogeocenoza v Listvennyh Molodnjakah. Izdatel'stvo 'Nanka', Moscow. pp. 264-9. [Ru., 7 refs.]
Presents a local yield table (site class 1) to age 65 years, for this part of S. central Russia, and describes the method of compilation.

Zmakin, A. S. 1968. [GROSS AND MERCHANTABLE YIELD OF OAK AND ASPEN STANDS.] Lesn. Z., Arhangel'sk 11 (2): 29-31 + 1 tbl. [5 refs. [Ru.].]
Gives tabulated data for coppice Oak, ordinary Aspen, and rot-resistant Aspen, throughout the life of the stands on 45- and 55-year rotations in S. central Russia. The rot-resistant Aspen was clearly superior.

Zmakin, A. S. 1968. [THE PRODUCTIVITY OF STANDS OF THE ROT-RESISTANT FORM OF ASPEN.] Lesn. Hoz. (12), (24). [Ru.]

568 OTHER MENSURATIONAL STUDIES OF STAND CONSTITUTION AND CHANGES THEREIN. DISTRIBUTION OF GROWTH BY TREE CLASSES, ETC.

Ivanescu, D. 1965. [SOME MENSURATIONAL ASPECTS OF POPULUS TREMULA GROWING IN ASSOCIATION WITH OTHER SPECIES IN A HILLY REGION [OF THE E. CARPATHIANS].] Rev. Padurilor 80 (10): 511-3 + smries. 1 ref. [Ru.ru.e.] 4 tbls.

58 SURVEYING AND MAPPING. AERIAL SURVEY

Wastenson, L., Klevemark, E., and Holmgren, B. 1972. PHOTO INTERPRETATION OF TREE SPECIES, AQUATIC MACROPHYTES AND BEDROCK OUTCROPS: COMPARATIVE STUDIES IN DIFFERENT AERIAL PHOTOGRAPHS. Svensk Lantmateritidskrift 64 (2): 152-186. [E.sv., 29 ref., NLL]

6 FOREST MANAGEMENT

61 FOREST MANAGEMENT: GENERAL, THEORY AND PRINCIPLES

Koncevoj, P. Ja. 1965. [METHODS OF MANAGING ASPEN STANDS.] Lesn. Hoz. 18 (10): 48-9. [Ru.]
The author advocates specialized management for this species, reducing the age-class interval to 5 years, and carrying out the principal felling at 30 years.

Pavlov, V. M., and Stepin, V. V. 1968. [MERCHANTABILITY AND EXPLOITABLE AGE OF POPULUS TREMULA STANDS IN THE CENTRAL PART OF THE EUROPEAN U.S.S.R.] Lesn. Z., Arhangel'sk 11 (1): 41-3. [Ru.]
It is concluded that the exploitable age of 40-50 years that is usually advocated does not take sufficient account of the losses incurred after the onset of stem rot. Maximum pulpwood yields would be obtained if the felling age were reduced to 35-40 years.

Petrov, M. F., and Sinel'scikova, Z. I. 1965. [THE RATIONAL EXPLOITATION OF STANDS OF BROADLEAVED SPECIES IN THE URALS AND [W.] SIBERIA.] Lesn. Hoz. 18 (7): 33-6. [Ru.]
Recommendations are made for achieving more efficient utilization and a reduction in wastage.

Vhirov, V. E., et al. 1967. [THE ROTATION AGE OF POPULUS TREMULA STANDS IN BELORUSSIA.] Lesn. Z., Arhangel'sk

10 (5): 60-3. [3 refs. [Ru.].]
Gives tables showing assortment structure by stand age, and assortment yields and revenue by rotation age.

65 SPECIAL BUSINESS PROBLEMS OF TIMBER-GROWING

Kostjukovic, F. T. 1964. [THE ECONOMIC MATURITY [ROTATION] OF FOREST.] Lesn. Z., Arhangel'sk 7 (2): 39-41. 8 refs. [Ru.]

66 COSTING OF LOGGING OPERATING

Anonymous. 1969. [CONVERTING AND DELIVERING INDUSTRIAL WOOD OF BROADLEAVED SPECIES IN LONG LENGTHS.] HESPA Mitteilungen, Luzern 19 (2): pp. 28. [G. Also in Wald u. Holz 1969 (50) (Sonderheft).]
Presents practical instructions for the sale of wood of broadleaved species (Beech, Poplar and Aspen) by dry weight in tree or crane lengths in Switzerland.

8 FOREST PRODUCTS AND THEIR UTILIZATION

81 WOOD AND BARK: STRUCTURE AND PROPERTIES

811 STRUCTURE. IDENTIFICATION

811.1

Einspahr, D. W., Harder, M. L., and Benson, M. K. 1972. WITHIN-TREE VARIATION IN FIBER LENGTH OF YOUNG QUAKING ASPEN. Genetics and Physiology Notes, institute of Paper Chemistry No. 13, 8 pp. [E., 1 ref.]
The pattern of within-tree fibre length was examined in 10- to 17-year-old natural P. tremoloides, plantation grown diploid P. tremuloides and triploid hybrid P. tremuloides X P. tremula.

Il'in, A. M. 1972. [QUANTITATIVE ANATOMICAL FEATURES OF THE WOOD OF MALE AND FEMALE ASPEN.] Biologicheskie Nauki No. 11, 65-66. [Ru., 4 ref., NLL]

Kalinkov, V., and Dobrinov, I. 1964. [STUDY ON THE ANATOMICAL STRUCTURE OF WOOD OF CERTAIN POPULUS TREMULA CLONES IN BULGARIA.] Naue. Trud. Lesotch. Inst., Sofija 12, (41-56). 7 refs. [Bulg.g.]

Norberg, P., and Meier, H. 1966. [PHYSICAL AND CHEMICAL PROPERTIES OF THE GELATINOUS LAYER IN TENSION WOOD FIBRES OF ASPEN (POPULUS TREMULA L.).] Holzforschung, Berlin 20 (6): 174-178. [6 Abb., 2 Tab., 14 Lit. Ang., dt.Zsfg.]

Sheldrake, A. R. 1971. AUXIN IN THE CAMBIUM AND ITS DIFFERENTIATING DERIVATIVES. J. Exp. Bot. 22 (72): 735-40. [24 ref. OBD]
Amounts were greatest in xylem samples, less in the cambium and least in the phloem. It is suggested that growth substances are actually formed in differentiating xylem.

Smilga, Ja. Ja. 1967. [ANATOMICAL STRUCTURE OF THE WOOD OF POPULUS TREMULA GROWING IN LATVIA.] Lesoved., Moskva (4), (71-6). [10 refs. [Ru.e.].]

Tehnerjadnov, A. V., and Somanov, Z. S. 1968. [ANALYSIS OF THE VARIATION IN FIBRE LENGTH IN ASPEN IN NATURAL POPULATIONS IN E. KAZAKHSTAN.] Auyl Saruasylyk Gylymynyn Habarsysy (11), (62-8). [[Ru.kazakh] From abstr. in Referat. Z., Moskva 1969 (7.56.96). [Ru.] N.L.L.]
No statistically significant differences in fibre length were found between the green-barked, light-barked, and yellow-barked forms. Site conditions and tree age (in the range 20-60 years) had a greater influence on fibre length than did the hereditary features of individual trees or their bark colour.

811.115

Sauter, J. J. 1967. ZUR ZYTOCHEMISCHEN OXYDASE-LOKALISATION IN SPHAROSOMEN DER FETTSPEICHERNDEN HOLZSTRANLZELLEN VON POPULUS.] Naturwissenschaften, Berlin 54 (7): S.176, [1 Abb., 7 Lit.Ang.]

811.2

Heinowicz, Z. 1967. SOME OBSERVATIONS ON THE MECHANISM OF ORIENTATION MOVEMENT OF WOODY STEMS. Amer. J. Bot. 54 (6): 684-9. [10 refs. O.B.D.]

Norberg, P. H., and Meier, H. 1966. THE GELATINOUS LAYER IN TENSION WOOD FIBRES OF ASPEN (POPULUS TREMULA L.). News Bull. Int. Ass. Wood Anatomists (1), (3-10). [14 refs.]
The present authors' findings controvert Sachsse's statement that the G-layer of tension-wood fibres in Poplar has a honeycomb structure.

811.22

Blum, W. 1972. [EXPERIMENTAL INDUCTION OF REACTION-WOOD FORMATION IN SPRUCE AND POPLARS.] Berichte der Schweizerischen Botanischen Gesellschaft 80, (225-251). [De., From Berichte Biochemie und Biologie 357, 1046. De.]

811.5

Nekrasova, G. N. 1970. [THE PROCESS OF HEARTWOOD FORMATION IN ASPEN, IN CONNEXION WITH SELF-PRUNING.] Lesn. Z. 13 (5): 27-30. [Ru., 14 re s.]
It seems that the appearance of heartwood in live branches initiates the process of self-pruning in that part of the stem.

Nekrasova, G. N. 1973. [OXYGEN ABSORPTION BY ASPEN WOOD IN RELATION TO HEARTWOOD FORMATION.] Biologicheskie Nauki No. 1, 67-70 [Ru., 11 ref., NLL]
The respiration rate decreased with age in the sapwood, increased somewhat at the sapwood/heartwood boundary, and then decreased in the heartwood. Changes in the rate of O_2 absorption are associated with the different types of heartwood formation.

811.7

Kosicenko, N. E. 1969. [THE 'ANNUAL RINGS' OF THE BAST OF WOODY SPECIES.] Lesn. Z., Arhangel'sk 12 (1): 33-7. [Ru., 11 refs.]
It is concluded that the formation, changes and distribution of the anatomical elements of the bast enable 'annual rings' to be distinguished with reasonable certainty.

Kosicenko, N. E. 1969. [CHANGES WITH AGE IN THE ANATOMICAL STRUCTURE OF PHLOEM OF POPULUS TREMULA.] Nauc. Dokl. Vyss. Skoly (Biol. Nauki), Moskva (1), (61-8). [4 refs. [Ru.ru.] N.L.L.]

Raskatov, P. B., and Kosicenko, N. E. 1968. [CHARACTERISTICS OF PHLOEM ELEMENTS IN DIFFERENT PARTS OF POPULUS TREMULA STEMS.] Bot. Z., 53 (11): 1612-6. [8 refs. [Ru.e.]

Savel'eva, T. E. 1972. [COMPARATIVE ANATOMY OF THE BARK OF ROOTS AND BRANCHES OF SOME WOODY SPECIES.] Biologicheskie Nauki No. 8, 64-68. [Ru., 8 ref., NLL]

812 PHYSICAL AND MECHANICAL PROPERTIES

Georgievski, Z. 1973. [TECHNICAL PROPERTIES OF [WOOD OF] POPULUS TREMULA.] Godisen Zbornik, Zemjodelsko-Sumarskiot Fakultet na Univerzitetot, Skopje (Summarstvo) 25, 175-196. [Ma.e., 5 ref.]

Polubojarinov, O. L. 1964. [PHYSICAL AND MECHANICAL PROPERTIES OF DEFECTIVE ASPEN WOOD.] Lesn. Z., Arhangel'sk 7 (6): 125-9. 8 refs. [Ru.]

Rangelov, K. 1969. [COMPARATIVE STUDIES OF CERTAIN PHYSICAL AND MECHANICAL PROPERTIES OF WOOD OF MALE AND FEMALE ASPENS.] Gorskostop. Nauka. Sofija 6 (4): 105-10. [Bulg.ru.g., 7 refs.]
Wood moisture content of the ♂ trees was generally 5-10% greater

than that of the ♀ trees. Sapwood contained ca. 50% more moisture than mature wood. Wood density of ♂ trees averaged 5%, and strength properties 4-18% more than the values for ♀ trees.

812.1

Dolacis, J. A., and It'jasov, S. G. 1968. [THE REFLECTION CAPACITY OF WOOD IN THE INFRA-RED PART OF THE SPECTRUM.] Derev. Prom. 17 (7): 16-7. [[Ru.] P.R.]
Results (graphed) show that the dependence of the spectral reflection capacity of the different species on wavelength is identical. Selective reflection (depending on wavelength of the incident radiation) is characteristic of wood. Reflection increases with increasing thickness of the wood specimen.

Dolacis, J. A., and Il'jasov, S. G. 1970. [THE OPTICAL PROPERTIES OF WOOD AS REGARDS INFRA-RED RADIATION.] Lesn. Z., 13 (6): 68-73. [Ru., 8 refs.]

812.2

Isaeva, L. N. 1966. [DISTRIBUTION OF MOISTURE IN THE STEMS OF GROWING TREES OF THE PRINCIPAL SPECIES IN E. SIBERIA.] In Svojstva drevesiny, ee zascita, i novye drevesnye materialy. Izdatel'stvo 'nauka', Moscow. pp. 3-10. 19 refs. [Ru.]

Ogarkova, T. V. 1964. [EFFECT OF HYGROSCOPIC MOISTURE ON THE SHRINKAGE COEFFICIENT OF WOOD.] Lesn. Z., Arhangel'sk 7 (3): 125-31. 4 refs. [Ru.]
Graphs the relationship of the relative deformation in shrinkage (e, in %) to m.c. for Oak, Aspen, Birch and Pine in the radial and tangential directions.

Ogarkova, T. V. 1968. [INVESTIGATION OF THE DEPENDENCE OF THE SHRINKAGE COEFFICIENT OF COMPRESSED WOOD ON MOISTURE CONTENT.] Lesn. Z., Arhangel'sk 11 (2): 95-7. [1 ref. [Ru.].]

812.3

Einspahr, D. W., Benson, M. K., and Harder, M. L. 1972. WITHIN-TREE VARIATION IN SPECIFIC GRAVITY ON YOUNG QUAKING ASPEN. Genetics and Physiology Notes. Institute of Paper Chemistry No. 15, 8 pp. [E., 6 ref.]

Isaeva, L. N., and Brjuhanova, F. B. 1967. [VARIATION IN DENSITY IN THE STEMS OF THE MAIN FOREST-FORMING SPECIES OF SIBERIA.] In Drevesina, ee zaseita i plastiki. Izdatel'stvo 'Nauka', Moscow. pp. 3-13. [Ru.]
In P. sylvestris and B. alba, density decreases from periphery to centre, whereas in P. tremula it increases.

Klemm, W. 1966. [USE OF Y-RAYS FOR THE DETERMINATION OF THE SPECIFIC GRAVITY OF WOOD.] Arch. Forstw. 15 (5/6): 611-5. [10 refs. [G.g.ru.e.].]

812.7

Orlov, A. V., and Kapustin, M. G. 1972. [DETERMINING THE MODULUS OF ELASTICITY ON SPECIMENS OF MODIFIED ASPEN.] Nauchnye Trudy, Leningradskaya Lesotckhnicheskaya Akademiya No. 151, 58-59. [Ru., NLL]

Simonov, M. N., and Maiorova, A. G. 1971. [THE STRENGTH OF BARK AND WOOD AT LOW TEMPERATURES.] Lesn. Zh. 14 (2): 81-6. [Ru.]

813 WOOD CHEMISTRY

Domburg, G. E., and Sergeeva, V. N. 1970. [KINETICS OF THERMAL DECOMPOSITION OF LIGNIN SULFATE OF POPULUS TREMULA.] Khim Drevesiny 6: 133-139. [Ru.]

Riscuta, S. 1971. [THE CHEMICAL COMPOSITION OF THE WOOD OF POPULUS TREMULA.] Bul. Inst. Polit. Brasov (Ser. B.: Econ. for.) No. 13, (317-25). [Ro.f., 6 ref.]

Sapotnitskii, S. A., Menshutkin, V. I., and Sabantseva, L. A. 1971. [THE EFFECT OF EXTRACTS OF POPULUS TREMULA ON YEAST MANUFACTURE.] Gidroliz. Lesokhim. Prom. 5: 6-7. [Ru.]

813.1

Sharkov, V. I., Kuibina, N. I., et al. 1971. [COMPARATIVE CHARACTERISTICS OF THE HEMICELLULOSES OF WOOD OF POPULUS TREMULA AND PINUS SIBIRICA.] Khim. Drev. No. 8, (27-34). [Ru., 12 ref. PR.]

Sharkov, V. I., Kuibina, N. I., and Solov'ena, Yu. P. 1970. GLUCOMANNAN FROM ASPENWOOD. Zhurnal Prikladnoi Khimii 43 (9): 2112-4. [Ru., 9 ref. Title from Abstr. Bull. Inst. Paper Chem. 1971, 42 (6): No. 5693. LTP.]

813.2

Assarsson, A., and Akerlund, G. 1966. STUDIES ON WOOD RESIN, ESPECIALLY THE CHANGE IN CHEMICAL COMPOSITION DURING SEASONING OF THE WOOD. PART 4. THE COMPOSITION OF THE PETROLEUM ETHER SOLUBLE NONVOLATILE EXTRACTIVES FROM FRESH SPRUCE, PINE, BIRCH AND ASPEN WOOD. Svensk PappTidn. 69 (16): 517-25. [17 refs. [E.e.sw.g.] P.R.]
Comparison of the main resin fractions from the various species showed that resin acids and volatile terpenes are found in the softwoods but not in the hardwoods. Both groups contain the same saturated hydrocarbons, and to some extent the same unsaturated hydrocarbons, waxes, glycerides and higher alcohols.

Assarsson, A., and Akerlund, G. 1967. STUDIES ON WOOD RESIN, ESPECIALLY THE CHANGES DURING SEASONING OF THE WOOD. PART 5. CHANGES IN COMPOSITION OF NONVOLATILE EXTRACTIVES DURING WATER SEASONING OF UNBARKED SPRUCE, PINE, BIRCH AND ASPEN LOGS. Svensk PappTidn. 70 (6): 205-12. [21 refs. [E.e.sw.g.] P.R.]
Unbarked logs were stored in water and examined after 6 and 12 months. During seasoning, the quantity of triglycerides decreased and that of fatty acids increased; this is interpreted as showing enzymatic hydrolysis by wood lipase.

Lindgren, B. O., and Svahn, C. M. 1966. SEPARATION OF TRIMETHYLSLYL ETHERS OF TRITERPENES BY THIN LAYER CHROMATOGRAPHY: TRITERPENES IN WOOD FROM POPULUS TREMULA L. Acta chem. scand. 20 (7): 1763-8. [16 refs. [E.e.] O.R.S.]

813.4

Ivanov, M. A., Buhteev, B. M., et al. 1970. [THE INFLUENCE OF TEMPERATURE AND pH ON THE CONCENTRATION OF FREE RADICALS IN WOOD, AND ITS WHITENESS.] Bumaz. Prom. (4), (22-23). [Ru.e., 13 refs. N.L.L.]

Melcer, I., and Melcerova, A. 1972. [SOME ASPECTS OF HYDROTHERMAL TREATMENT OF WOOD OF POPULUS TREMULA L.] Cellulose Chemistry & Technology 6 (6): 681-694. [De.en.f., 12 ref.] From Abstract Bulletin of the Institute of Paper Chemistry 44, 4056. LTP.

813.9

Nagoda, L. 1964. [WHY IS WOOD ACID?] Norsk Skogbr. 10 (17): 458-60. 10 refs. [Nor.]

815 EFFECT OF GROWTH FACTORS ON STRUCTURE AND PROPERTIES

Jakimov, I. V. 1966. [THE EFFECT OF MINERAL FERTILIZERS ON THE PHYSICAL AND MECHANICAL PROPERTIES OF ASPEN WOOD.] Lesn. Hoz. 19 (3): 32. [Ru.]

Jakimov, I. V. 1968. [EFFECT OF AGE ON THE ANATOMICAL STRUCTURE AND TECHNICAL PROPERTIES OF ASPEN WOOD.] Nauc. Trud. Voronez. Lesotch. Inst. (30), (127-31). [Ru. From abstr. in Referat. Z., Moskva 1969 (11.56.106). Ru. N.L.L.]
Studies on material from Populus tremula in S. central Russia showed that annual ring width decreases from age class II to IV and scarcely changes thereafter. Cell-wall thickness of the fibres and wood density both increase from age class II to V and do not change thereafter. Fibre lumen diameter decreases from age class II to VI by 11-9%. Vessel diameter is greater in early than in late wood. The contents of mechanical tissues and values for most of the physical and mechanical properties increase from age class II to V and decrease thereafter.

82 CONVERSION, SHAPING, ASSEMBLY AND FINISHING OF WOOD; GENERAL

821 BARKING

Arola, R. A. 1973. COMPRESSION DEBARKED CHIPS FROM A WHOLE-TREE CHIPPER. USDA Forest Service Research Note, North Central Forest Experiment Station No. NC-147, 4 pp. [E., 8 ref.]

Frid, L. D. 1967. [INVESTIGATION OF THE PROCESS OF BARKING BROADLEAVED SPECIES.] Lesn. Z., Arhangel'sk 10 (4): 83-9. [Ru.]

Polozov, M. 1972. [A PROMISING METHOD OF BARKING WOOD.] Lesnaya Promyshlennost. No. 2, 21-22. [Ru., 1 ref.]
Gives the results of investigations on barking Spruce, Pine, Aspen and Birch with jets of compressed air with a sawdust filler.

Rushnov, N. P., Pryakhin, E. A., and Maslovskii, V. I. 1973. [THE BARKING OF CHIPS IN CHIPPERS.] Lesnaya Promyshlennost' No. 7, 25. [Ru.]
Theoretical analysis [not outlined here] has shown that the use of special plates installed below the knives improved the efficiency of barking during the chipping of unbarked wood. Investigations were made with such plates, having sharpness angles of 30-90°, installed 6-19 mm from the edges of the knives.

Sosunov, P., and Seljuga, A. 1971. [DRY BARKING OF WOOD IN DRUMS.] Lesn. Prom. (4), (13-4). [Ru.]
Pulpwood of 7 Far Eastern conifers and hardwoods was dry-barked by the BOMP-3 drum barker. Cleanness of barking and losses of wood are plotted against duration of barking.

Zadoroznyj, V. V., and Mireckij, V. O. 1968. [BARKING WOOD WITH THE AID OF ELECTRIC CHARGES IN WATER.] Lesn. Prom. (11), (11-2). [Ru.]
It was found best to install the electrodes parallel to the log and 10-15 mm. from it. Optimum parameters were: capacitance 2 microfarads; voltage 35-50 kV. The unusual feature of this method was that barking quality was better for Birch and Aspen than for Spruce.

823 PLANING, CUTTING OF MOULDINGS. CHISELLING, MORTISING AND TENONING. BORING. TURNING

Syrodaev, G. A., and Melnikov, A. V. 1968. [INVESTIGATION OF THE PROCESS OF ROTARY CUTTING OF DENSIFIED (COMPRESSED) WOOD.] Nauc. Trud. Leningr. Lesoteh. Akad. No. 113, (30-6). [Ru.ru.]
Optimum angles were found to be: cutting angle 20°, sharpness angle 60°, and clearance angle 10°, for feed speeds of 8, 12 and 8 m./min. and cutting depths of 1, 2 and 3 mm.

827 BENDING. MOULDING (OTHER THAN BY CUTTING)

Vascev, N. V., and Modin, N. A. 1968. [A RATIONAL METHOD OF DENSIFYING WOOD.] Nauc. Trud. Leningr. Lesoteh. Akad. No. 111, (51-8). [Ru.]
Trials were made of compressing Aspen wood by first heating it (to 100-160° C.), then compressing it in an unheated hydraulic multi-daylight press, and then holding it in the compressed state for 1/2 – 2 hr. The best schedules were: heating at 120 – 140° by dry air for 1 hr. (or by superheated steam for 1/2 hr.), continuous compression in the press, and then holding for 1/2 – 1 hr.

829 MISCELLANEOUS

Cernenko, S. A. 1964. [DEEP STAINING OF ASPEN WOOD BY PRESSURE IMPREGNATION FROM THE END.] Derev. Prom. 13 (12): 15-7. 1 ref. [Ru.] P.R.

83 TIMBER MANUFACTURING INDUSTRIES AND PRODUCTS

832 MILLS, THEIR FUNCTIONS AND PRODUCTS

832.15

Nikanov, V. I. 1965. [THE YIELD AND DEFECTS OF UNEDGED LUMBER FROM ASPEN SAWLOGS.] Lesn. Z., Arhangelsk 8 (6): 111-4. [Ru.] [3 tbls.]

Nikanov, V. I. 1966. [DEFECTS AND THEIR RELATIONSHIP TO ASPEN SAWLOG GRADES.] Lesn. Z., Arhangelsk 9 (5): 117-9. [Ru.] [1 gph., 2 tbls.]

832.3

Adema, K. 1971. POPULUS TREMULA. Populier 8 (4): 27-9. [Du.]
A general appraisal, including: a mention of promising growth results with a P. canescens X P. tremula hybrid at Best, Netherlands, the use of Aspen in the landscape; and, in particular, the use of Aspen wood in the manufacture of matches.

833 TIMBER IN BUILDINGS AND ENGINEERING STRUCTURES (MANUFACTURE AND USE)

833.1

Ovcharenko, V. P. 1972. [THE EFFECTIVENESS OF PRODUCING PANEL PARQUET FACED WITH COMPRESSED WOOD OF SOFT-WOODED BROADLEAVED SPECIES.] Nauchnye Trudy, Leningradskaya Lesotekhnicheskaya Akademiya No. 153, 56-60. [Ru., 3 ref., NLL]
An analysis of the economics of using compressed wood of Aspen as a replacement for Oak in panel parquet in the USSR. The analysis indicates that such production would be economically advantageous.

833.2

Langhammer, A. 1965. [[THE USE OF] ASPEN FOR HOUSEBUILDING.] Norsk Skogbr. 11 (3): 81-5. 22 refs. [Nor.e.]

833.4

TSel'millere, M. I. 1973. [RESEARCH ON IMPREGNABILITY OF BETULA AND POPULUS TREMULA WOOD USED IN FARM CONSTRUCTION.] In Produkty Pereabotki Drevesiny Sel'skomu Khoziaistvu Tezisy Dokladov Vsesoiuznoi Konferentsii 3: 93-7. [Ru.]

84 PRESERVATION AND OTHER TREATMENTS TO IMPROVE THE PROPERTIES OF WOOD. DAMAGING INFLUENCES

841 WOOD PRESERVATION

Kalnins, A. J., et al. 1968. [IMPREGNATION OF SMALL ASSORTMENTS BY THE DIFFUSION METHOD.] Lesn. Prom. (6), (7). [Ru.ru.]

Rusinya, N. A. [Rusina, N.] 1974. [BREAKDOWN OF WOOD IN FIELD CONDITIONS.] Latvijas PSR Zinatnu Akademijas Vestis No. 1, 30-36. [Ru.e., 9 ref. CGB.]

Tselmillere, M. Ya., and Saulite, L. A. 1973. [FIXATION OF THE COMPONENTS OF COMBINED PRESERVATIVES BY WOOD FROM DIFFERENT PARTS OF THE TREE.] Khimiya Drevesiny No. 13, 109-113. [Ru., 13 ref., PR]

Vakin, A. T., et al. 1968. [COMPOUND [FUNGAL AND BACTERIAL] ROT OF WOOD IN COOLING TOWERS OF POWER STATIONS, AND MEASURES FOR CONTROLLING IT.] Nauc. Trud. Leningr. Lesoteh. Akad. No. 110, (91-100). [16 refs. [Ru.].]

842 TREATMENTS TO IMPROVE THE RESISTANCE OF WOOD TO PHYSICAL AND CHEMICAL AGENCIES

Anonymous. 1974. MIT AMMONIAK PLASTIFIZIERTES HOLZ ALS FUSSBODEN. Holz-Zentralbl., Stuttg. 100, (91): S.1383.

Fuhrjanskij, P. N. 1964. [COMPRESSING WOOD.] Izdatelstvo Lesnaja Promyslennost', Moscow. pp. 351. 16 refs. [Ru.] N.L.L.
The third, revised and expanded, edition of a book dealing with all aspects of wood compression in the U.S.S.R.

Galnin'sh, A. Y., Koroikiya, G. Y., and Berzinsh, G. V. 1972. TESTING THE RESISTANCE OF PLASTICIZED WOOD TO BIOLOGICAL AGENCIES.] Khimiya Drevesiny No. 12, 131-133. Ru., 7 ref. NLL]

Kotov, V. M. 1970. [EFFECT OF THE DEGREE OF DENSIFICATION ON THE COEFFICIENT OF VISCOSITY OF COMPRESSED ASPEN WOOD.] Lesn. Z. 13 (5): 77-9. [Ru., 4 refs.]

Polubojarinov, O. I. 1968. [INVESTIGATION OF THE FUNGUS RESISTANCE OF ROTTEN ASPEN WOOD, TREATED WITH CERTAIN POLYMERS, BY THE AID OF RADIOACTIVE ISOTOPES.] Nauc. Trud. Leningr. Lesoteh. Akad. No. 110, (54-9). 3 refs. [Ru.ru.].]
Rotton wood was impregnated with urea-formaldehyde resin or styrene. The treatment improved the physical and mechanical properties of the wood. and its resistance to Coniophora cerebella.

Scerbak, M. M. 1964. [COMPRESSING WOOD BY ROLLING.] Derev. Prom. 13 (12): 11. [Ru.] P.R.

Vascev, N. V., et al. 1965. [DENSIFIED WOOD FOR MAKING SHOE] LASTS.] Derev. Prom. 14 (6): 15. [Ru.] P.R.
Describes the manufacture of lasts from densified wood of Aspen, Alder, Birch, etc. as a substitute for the normal material, Beech. Tests showed the densified substitute species to be quite satisfactory, and their use would result in a considerable financial saving.

844 ATTACK BY PLANT ORGANISMS

844.1

Henningsson, B. 1967. THE PHYSIOLOGY, INTER-RELATIONSHIPS AND EFFECTS ON THE WOOD OF FUNGI WHICH ATTACK BIRCH AND ASPEN PULPWOOD. Uppsats. Instn. Virkeslara Skogshogsk., Stockh. No. U 19. pp. 10. [26 refs. [E.] (Repr. from Acta Universitatis Upsaliensis: Abstracts of Uppsala Dissertations in Science No. 100, 1967).]

844.2

Belenkov, D. A. 1965. [THE RESISTANCE OF SCOTS PINE, BIRCH AND ASPEN WOOD TO HOUSE FUNGI.] Lesn. Z., Arhangelsk 8 (1): 105-8. [Ru.]
Specimens of the three species were exposed to attack by Coniophora cerebella, Poria vaporaria, Merulius lacrymans and Fomes pinicola. Tabulated weight losses show that Aspen and Birch were generally as resistant to the house fungi as Pine sapwood. NaF proved to be a more effective preservative than Na dinitrophenolate, and was more effective on Birch and Aspen than on Pine sapwood. Accordingly, there is no reason why Aspen and Birch should not be widely used in building.

Churikova [Curikova], E. K. 1968. INVESTIGATIONS ON THE DURABILITY OF ASPEN WOOD. Transl. Dep. For. Can. No. 221, pp. 4. [Transl. by J. Freyman from Lesn. Hoz. 1967 (8), (51-2).

Curikova, E. K. 1967. [INVESTIGATION OF THE DURABILITY OF ASPEN WOOD.] Lesn. Hoz. (8), (51-2). [Ru.]
Shows graphically the weight losses of wood of five clones and of the light-barked form of Populus tremula when exposed to cultures of Coniophora cerebella. In the early stages (up to ca. 90 days' exposure), weight losses of the Aspen were less than those of Scots Pine sapwood tested for comparison.

Henningsson, B. 1967. INTERACTIONS BETWEEN MICRO-ORGANISMS FOUND IN BIRCH AND ASPEN PULPWOOD. Stud. for. suec. Skogshogsk., Stockh. No. 53, pp. 32. [32 refs. [E.e.sw.] Price Kr.5.]

Henningsson, B. 1967. MICROBIAL DECOMPOSITION OF UNPEELED BIRCH AND ASPEN PULPWOOD DURING STORAGE. Stud. for. suec. Skogshogsk., Stockh. No. 54, pp. 32. [27 refs. [E.e.sw.] Price Kr.5.]

Henningsson, B. 1967. PHYSIOLOGY OF FUNGI ATTACKING BIRCH AND ASPEN PULPWOOD. Stud. for. suec. Skogshogsk., Stockh. No. 52, pp. 55. [100 refs. [E.e.sw.] Price Kr. 8.]
Discusses results of laboratory studies on the C and N nutrition of 15 fungi, their thiamin requirements and the effect of pH and temperature on growth.

Lundstrom, H. 1973. STUDIES OF THE WOOD-DECAYING CAPACITY OF THE SOFT-ROT FUNGI ALLESCHERIA TERRESTRIS, PHIALOPHORA (MARGARINOMYCES) LUTEO-VIRIDIS AND PHIALOPHORA RICHARDSIAE. Rapporter, Institutionen for Virkeslara No. R 87, 2 + 23 pp. + 10 tab., 14 fig. [E.sv., 40 ref.]

Nekrasova, G. N. 1968. [EFFECT OF EXTRACTIVES OF ASPEN WOOD ON THE GROWTH OF THE MAIN FUNGI DESTROYING ITS HEARTWOOD.] Nauc. Trud. Leningr. Lesoteh. Akad. No. 110, (47-53). [16 refs. [Ru.ru.].]
Extractives from the outer heartwood were toxic towards Phellinus tremulae, P. igniarius and Corticium polygonum. Toxicity depended on heartwood type, but extractives from red heart were the most toxic to all three fungi.

Nguyen Van Thong. 1973. [DATA ON THE DECAY ACTIVITY OF SOME WOOD-ROTTING FUNGI.] Erdo 22 (7): 316-320. [Hu.ru.e., 3 ref.]

Nilsson, T. 1973. STUDIES ON WOOD DEGRADATION AND CELLULOLYTIC ACTIVITY OF MICROFUNGI. Studia Forestalia Suecica No. 104, 40 pp. [E.sv., 66 ref.]

Nilsson, T. 1974. FORMATION OF SOFT ROT CAVITIES IN VARIOUS CELLULOSE FIBRES BY HUMICOLA ALOPALLONELLA MEYERS & MOORE. Studia Forestalia Suecica No. 112, 30 pp. [E.sv., 43 ref.]

Polubojarinov, O. I. 1965. [USE OF RADIO-ACTIVE ISOTOPES IN INVESTIGATING THE RESISTANCE OF WOOD TO BIOLOGICAL AGENCIES.] Lesn. Z., Arhangelsk 8 (1): 101-4. 4 refs. [Ru.]
Results are tabulated for Birch, sapwood of Scots Pine, and for sapwood, mature wood and wet wood of Aspen.

Smilga, Ja. Ja. 1968. [INVESTIGATIONS ON THE ROT RESISTANCE OF ASPEN WOOD.] In Povysenie produktivnosti lesa. Izdatelstvo 'Zinatne', Riga., pp. 115-20. [[Ru.latv.g.] N.L.L.]
Differences between samples from different sides of the tree (N., S., E., or W.), from different heights, from different site types, and from different forms of Aspen were not significant. Wood from the stem centre was more resistant than peripheral wood.

Suvorov, P. A. 1968. [THE WOOD-DESTROYING CAPACITY OF GANODERMA APPLANATUM.] Arch. Forstw. 17 (9); 937-41. [7 refs. [G.g.ru.e.].]

847 DRYING (SEASONING)

Haygreen, J. G., and Turkia, K. 1968. TECHNICAL AND ECONOMIC CONSIDERATIONS IN THE PLATEN DRYING OF ASPEN SAPWOOD AND PAPER BIRCH CUT-STOCK. For. Prod. J. 18 (8): 43-50. [6 refs.]

Turkia, K., and Haygreen, J. [G.] 1968. PLATEN DRYING OF ASPEN SAPWOOD. For. Prod. J. 18 (6): 43-8. [9 refs.]

848 TIMBERYARD PRACTICE. HANDLING AND STORAGE OF TIMBER

Bergman, O., and Nilsson, T. 1967. [OUTSIDE STORAGE OF POPULUS TREMULA CHIPS AT HORNEFORS SULPHITE MILL.] Rapp. Instn. Virkeslara Skogshogsk., Stockh. No. R55, pp. 60 + 19 tbls., 25 gphs. & dgms., 10 photos. [74 refs. [Sw.sw.e.e.].]

Bergman, O., and Nilsson, T. 1971. REPORT ON OUTDOOR STORAGE OF ASPEN-WOOD CHIPS AT THE HORNEFORS SULFITE MILL. Transl. Dep. Fish. For. Can. No. OOFF-169, 1971. pp. 89. [74 refs. Transl. from Rapp. Instn. Virkeslara Skogshogsk. No. R-55, 1967.

Croon, I. 1965. [THE DEVELOPMENT OF RESIN MATURATION IN SOME CHIP PILES AND ITS CONSEQUENCES FOR THE SULPHITE AND SULPHATE PULP INDUSTRIES.] Svensk Papp Tidn. 68 (10): 378-83. [Sw.sw.] P.R.
In sulphate pulping, the effects of chip storage are largely negative; the resin content remains unaffected, or increases (particularly in unbleached Pine pulp); the yield of tall oil decreases and its composition changes.

Maslov, V. A., Kantemirova, L. A., and Sabantseva, L. A. 1974. [STORAGE OF HARDWOOD PULPWOOD IN PILES.] Bumazhnaya Promyshlennost' No. 2, 11-12. [Ru., NLL.]

Molotkov, L. K. 1972. [HEATING AND ALTERATIONS OF BIRCH AND ASPEN WOODS AS DETERMINED IN MODEL EXPERIMENTS.] Sb. Tr. VNII Tsellyul.-Bumazh. Prom. No. 6, 124-134. [Ru., 9 ref.] From Abstract Bulletin of the Institute of Paper Chemistry 44, 8476. LTP.

Molotkov, L. K. 1974. [THE DESTRUCTION OF ASPEN CHIPS DURING STORAGE.] Bumazhnaya Promyshlennost' No. 1, 5-6. [Ru., NLL]
In the first three months the loss in woody matter was 2.3-2.7% for sapwood chips, regardless of storage temperature, rising by 6 months to 6.1% for storage at 25 C and to 4.2% at 38 C. At all stages the losses were less for heartwood chips, being ca. 2% at 6 months.

Nilsson, T. 1965. [MICRO-ORGANISMS IN CHIP PILES.] Svensk Papp Tidn. 68 (15): 495-9, 2 refs. [Sw.sw.e.g.] P.R.
Preliminary results of a study of 8 chip piles of Birch, Aspen, Pine or Spruce, varying in size and storage period, showed a much greater microflora than in pulpwood stacks.

Schultze-Dewitz, G. 1970. [STUDIES ON THE INFLUENCE OF THE DURATION OF STORAGE OF ASPEN WOOD ON VARIOUS PROPERTIES.] Holzindustrie 23 (9): 278-80. [G., 16 refs., N.L.L.]
Results showed no significant deterioration but indicated that storage periods > 1 year were not advisable except in properly constructed stacks.

Zak, H. 1967. [CHIP STORAGE IN THE OPEN.] Holz-Kurier, Wien 22 (32/33): 9-12. [1 ref. [G.].]

849 MISCELLANEOUS

Melcer, I., and Melcerova, A. 1972. [SOME PHYSICAL AND CHEMICAL CHANGES IN HARDWOOD CELLULOSE AFTER HYDROTHERMAL TREATMENT.] Zbornik Vedeckych Prac Drevarskej Fakulty Vysokej Skoly Lesnickej a Drevarskej vo Zvolene 169-175. [Sk.ru.de., 32 ref.]

Melcer, I., Melcerova, A., Solar, R., Bella, A., Blaho, J., and Gajdos, E. 1972. [STUDY OF THE HYDROLYSATE AFTER HYDROTHERMAL TREATMENT OF POPULUS TREMULA WOOD.] Zbornik Vedeckych Prac Drevarskej Fakulty Vysokej Skoly Lesnickej a Drevarskej vo Zvolene 93-121. [Sk.ru.de., 74 ref.]

Melcerova, A., Melcer, I., and Solar, R. 1972. [SOME PHYSICAL AND CHEMICAL CHANGES IN HARDWOOD LIGNIN DURING HYDROTHERMAL TREATMENT.] Zbornik Vedeckych Prac Drevarskej Fakulty Vysokej Skoly Lesnickej a Drevarskej vo Zvolene 177-192. [Sk.ru.de., 46 ref.]

Melcerova, A., Melcer, I., and Tominova, V. 1972. [STUDY OF CHEMICAL CHANGES IN THE CONSTITUENTS OF POPULUS TREMULA WOOD DURING HYDROTHERMAL TREATMENT.] Zbornik Vedeckych Prac Drevarskej Fakulty Vysokej Skoly Lesnickej a Drevarskej vo Zvolene 123-167. [Sk.ru.de., 159 ref.]

85 "GRADING" OF WOOD AND WOOD PRODUCTS

Alekseev, V. A. 1971. [MOSSES ON ASPEN STEMS – INDICATORS OF WOOD QUALITY.] Lesn. Khoz. (2), (78). [Ru.]
A note based on observations in the Kalinin and Leningrad region pointing out that vigorous moss growth on the bark often indicat internal wood defects (wetwood and decay).

Bobrov, R. V. 1966. [CONDITIONS OF THE OCCURRENCE O RED STAIN IN ASPEN.] Lesn. Z., Arhangelsk 9 (5): 19-22. [Ru.
Stem analysis of Aspen from various plots showed that ste diameter had little effect on the % content of red-stained woo (false heartwood). The absolute volume of red-stained woo increased with increasing stem diameter and especially wi increasing branchiness (correlation coefficient 0·9).

Nekrasova, G. N. 1968. INVESTIGATION OF THE NATURE O ASPEN FALSE HEART. Transl. Dep. For. Can. No. 179, pp. 1. [14 refs., Transl. from Lesn. Z., Arhangelsk 1967, 10 (2): 87-91.

Polubojarinov, O. I., Solovev, V. A., and Nekrasova, G. N. 196 [DEFECTS OF ASPEN, AND NEW STANDARDS FOR ROUNI WOOD.] Lesn. Prom. (6), (9-10). [Ru.]

Rangelov, K. N. 1967. [STUDY OF STEM DEFECTS O POPULUS TREMULA IN BULGARIA.] Gorskostop. Nauka, Sofi 4 (6): 67-80. [6 refs. [Bulg.ru.g.] 8 photos. 7 tbls.]

86 PULP INDUSTRIES

861 PULP AND PAPER MANUFACTURE. TEXTILE AND OTHER CELLULOSE DERIVATIVES

Blechschmidt, J. 1970. [THE SUITABILITY OF VARIOUS WOO SPECIES FOR THE PRODUCTION OF MECHANICAL PULP. Zellstoff und Papier 19 (9): 268-275, 288. [De., 29 ref., NLL.]
The particle-size distribution and de-watering properties of Popla and P. tremula pulps were similar to those of P. abies. Poplar an Aspen are recommended for greater use in medium-fine printin papers and high-quality cardboards, but not in newsprint.

Bjorkman, E., et al. 1964. THE USE OF DECAYED WOOD FRO SOME CONIFERS AND BROADLEAF TREES FOR CHEMICA PULPING PURPOSES. Stud. for. suec. Skogshogsk., Stockh. No 21, pp. 66 + 12 photos. 90 refs. [E.e.sw.]

Bobrov, Y. A., Zhalina, V. A., and Savinova, V. N. 1973 [TECHNOLOGICAL PROPERTIES OF PULPWOOD FORMIN THE RAW MATERIAL FOR THE BRATSK LPK.] Nauchny Trudy, Leningradskaya Lesoteknicheskaya Akademiya No. 158 46-50. [Ru., NLL]

Domburg, G. E., and Gromov, V. S. 1964. [BREAKDOWN O CARBOHYDRATES AND FORMATION OF FURFURAL IN TH HYDROTROPIC COOKING OF HARDWOODS.] In Himiceskaj pererabotka i zascita drevesiny. Izdatelstvo Akademii Nau Latvijskoj SSR, Riga., pp. 53-60. 18 refs. [Ru.ru.] P.R.
Describes trials on Aspen and Birch, using a 40% solution of N xylenesulphonate as the hydrotropic solution.

Einspahr, D. W., Benson, M. K., and Peckham, J. R. 1969 OBSERVATIONS ON A BARK AND WOOD-CHIP SEPARATIO PROCEDURE FOR ASPEN. For. Prod. J. 19 (7): 33-6. [8 refs. [Cf. F.A. 30 No. 6647.]

Gromov, V. S., and Hrol, L. A. 1964. [EFFECT OF SALTS O VARIOUS COMPOSITION ON THE DISSOLUTION OF LIGNI AND CARBOHYDRATES OF HARDWOOD IN WATER AN HYDROTROPIC COOKS.] In Himiceskaja pererabotka i zasci drevesiny. Izdatelstvo Akademii Nauk Latvijskoj SSR, Riga. pp 35-52. 19 refs. [Ru.ru.] P.R.

Gugnin, J. A., et al. 1968. [THE STRUCTURE AND CHEMICAL COMPOSITION OF THE WOOD OF FAR EASTERN HARDWOO SPECIES.] Bumaz. Prom., Moskva (9), (8-9). [2 refs. [Ru.ru.e.] N.L.L.]

Henningsson, B. 1970. [YIELD AND PROPERTIES OF SULPHATE PULP FROM BIRCH AND ASPEN PULPWOO STORED IN THE FOREST.] Rapp. Instn. Virkeslara Skogshogsk. No. R 64, pp. 34. [Sw.e., 12 refs.]

Henningsson, B. 1972. YIELD AND PROPERTIES OF SULPHATE PULP FROM DECAYED BIRCH AND ASPEN PULPWOOD. In Biodeterioration of Materials. London, UK, Applied Science Publishers Ltd. 336-345. [E., 14 ref., PR]

Ivanova, I. S., Gugnin, Y. A., and Dolinko, V. V. 1972. [POSSIBILITY OF OBTAINING BLEACHED KRAFT PULP FROM FAR EASTERN HARDWOOD SPECIES.] In Issled. Oblasti Proizvod. Polufabrikatov, Ochistki Prom. Stokov. 60-68. [Ru.] From Abstract Bulletin of the Institute of Paper Chemistry 44, 3899. LTP.

Kosaya, G. S., Luzina, L. I., and Dolinko, V. V. 1972. [COMPARISON OF PINE, BIRCH, AND ASPEN [KRAFT] COOKS BASED ON DELIGNIFICATION SELECTIVITY AND ALKALI CONSUMPTION.] Sb. Tr. VNII Tsellyul.-Bumazh. Prom. No. 61, 77-83. [Ru., 4 ref.] From Abstract Bulletin of the Institute of Paper Chemistry 45, 437. LTP.
The results show clearly that the Pine, Birch and Aspen can be pulped jointly.

Kossoj, A. S., and Frolov, I. I. 1966. [PRODUCTION OF WHITE GROUNDWOOD PULP FROM ASPEN.] Bumaz. Prom., Moskva (6), (6-8). [[Ru.ru.e.] N.L.L.]
A dulled stone produced pulp of better quality than did a sharp stone, but caused a certain reduction in grinder output and an increase in power requirement. Aspen with a small amount of rot was suitable for pulping (with subsequent cleaning).

Krotov, V. S., Volobueva, E. S., and Nepenin, Y. N. 1973. [IMPREGNATION OF ASPEN CHIPS WITH SULPHATE LIQUOR BY MEANS OF REPEATED PRESSING.] Bumazhnaya Promyshlennost' No. 8, 5-7. [Ru., NLL.]

Krylov, V. N. 1973. [THE DEPENDENCE OF THE PHYSICAL AND CHEMICAL CHARACTERISTICS OF WOOD ON CERTAIN MENSURATIONAL INDICES OF THE STANDS.] Nauchnye Trudy, Leningradskaya Lesotekhnicheskaya Akademiya No. 158, 51-53. [Ru., 1 ref., NLL]
Results indicate that the main mensurational stand factors considered in sampling should be age and site class; mean height, mean diameter, forest type and stand density are not decisive factors in sampling.

Magister, G., and Reich, W. 1971. [THE SUITABILITY OF POPLAR WOOD FOR THE MANUFACTURE OF TEXTILES.] Zellstoff und Papier 20 (7): 195-202. [De., 34 ref.] From Cellulosa e Carta 23 (11): 82-83. It.
Compares the properties of bisulphite pulps made from Poplar with those made from Beech, noting the lower lignin content and apparent density of the Poplar pulps but also their greater ease of bleaching and higher yield.

Melms, F., Anders, W., and Reich, W. 1967. [THE EFFECT OF HEARTWOOD IN POPULUS TREMULA ON THE PROPERTIES OF SULPHITE PULP.] Zellstoff und Papier, Berlin 16 (12): 371-4. [G., 9 refs., N.L.L.]
Hardwood (h.w.) contained more lignin and less cellulose than sapwood (s.w.) and, in most cases, less alcohol-soluble extractives, and gave a lower pulp yield. Quality of bleached pulp from h.w. and s.w. differed little by classical tests, but h.w. viscose had a higher content of large particles and was more difficult to filter.

Nepenin, J. N., and Pogozeva, T. A. 1967. [OBTAINING BLEACHED SULPHATE PULP FROM BIRCH AND ASPEN WOOD.] Lesn. Z., Arhangelsk 10 (5): 136-40. [1 ref. [Ru.].]

Nepenin, J. N., and Verevkina, V. T. 1964. [SULPHITE COOKING OF HARDWOODS WITH ACID CONTAINING Na_2SO_4.] Lesn. Z., Arhangelsk 7 (5): 137-44. 6 refs. [Ru.]

Nepenin, J. N., Beigelman, A. V., and Vishnevskaya, N. S. 1971. [STRONG BLEACHED SULPHATE PULP FROM HARDWOODS.] Bumazh. Prom. (11), (12-4). [Ru., 6 ref., NLL]

Prey, V., and Schadenbock, W. 1972. VERGLEICHENDE ANALYSE VON HOLZERN IM HINBLICK AUF IHR SPATERES VERHALTEN IM ZELLSTOFFKOCHER. 2. MITT.: HYDROLOSE UND AUFLOSUNG DES HOLZES MITTELS SCHWEFELSAURE UND CUOXAM. Papier, Darmst. 26 (2): 63-71. [2 graph. Darst., 16 Tab., 17 Lit. Ang., Dt., e.u.f.Zsfg.]

Rutkowski, J. 1964. [THE INFLUENCE OF BARK ON THE PROPERTIES OF PULPS OBTAINED FROM HARDWOOD BY THE N[EUTRAL] S[ODIUM] S[ULPHITE] [SEMI-] C[HEMICAL] PROCESS.] Przeglad Papierniezy, Lodz 1963 (3), (65-9). [Pol.] From abstr. in Polish tech. Abstr. No. 1 (53), (No. 8469). [Ru.E.] P.R.
The presence of bark had a beneficial effect on the pulping process because it led to a slower decrease of pH during cooking and to a marked improvement in the beating properties of the pulp.

Schadenbock, W., and Prey, V. 1971. [COMPARATIVE ANALYSIS OF WOODS AS REGARDS THEIR COOKING PROPERTIES. I. COMPARISON OF BEECH AND SPRUCE WOOD BASED ON CONVENTIONAL METHODS OF ANALYSIS.] Papier 25 (11): 786-788. [De.e.f., 12 ref. PO]

Schadenbock, W., and Prey, V. 1972. [COMPARATIVE ANALYSIS OF WOODS AS REGARDS THEIR COOKING PROPERTIES. II. HYDROLYSIS AND DISSOLUTION OF WOOD WITH SULPHURIC ACID AND CUOXAM.] Papier 26 (2): 63-75. [De.e.f., 27 ref. PO]

Schultze-Dewitz, G. 1971. INVESTIGATION OF THE INFLUENCE OF STORAGE TIME OF ASPEN WOOD ON ITS VARIOUS PROPERTIES. Transl. Environm. Can. No. OOENV 8, pp. 13. [16 ref. Transl. from Holzindustrie 1970 23 (9): 278-80.

Shcherbakova, L. D., Ivanov, M. A., and Kleimenova, T. A. 1972. [CHANGES IN THE CARBOHYDRATE COMPOSITION OF SPRUCE, BIRCH, AND ASPEN WOODS CAUSED BY HEATING IN BUFFER SOLUTIONS (pH 1-12.3) AT TEMPERATURES FROM 120 TO 180° C.] Sb. Tr. VNII Tsellyul.-Bumazh. Prom. No. 61, 4-14. [Ru., 18 ref.] From Abstract Bulletin of the Institute of Paper Chemistry 45, 442. LTP.

Siren, G., Jensen, W., and Lonnberg, B. 1974. SHORT-ROTATION WOOD IN PULP FOR PAPERMAKING. In Symposium Internacional EU CE PA, Madrid. Paper No. 2, 26 pp. [E., 15 ref.]

Sluziteleva, V. N., and Nepenin, J. N. 1968. [CHEMICAL CHANGES IN THE WOOD SUBSTANCE AND THE COOKING LIQUOR DURING SULPHATE PULPING OF HARDWOODS.] Bumaz. Prom., Moskva (3), (4-6). [15 refs. [Ru.ru.e.] N.L.L.]
Changes in wood chemistry and in the liquor during kraft pulping of Aspen and Birch are identical. It is therefore possible to cook the two species together.

Swedish Association of Pulp and Paper Engineers. 1968. [SUMMARIES OF PAPERS PRESENTED AT A CONFERENCE ON FIBRE MORPHOLOGY AND FIBRE PROPERTIES [ORGANIZED BY THE SWEDISH ASSOCIATION OF PULP AND PAPER ENGINEERS], STOCKHOLM, 16-17 JANUARY, 1968.] Svensk PappTidn. 71 (2): 54-8. [[Sw.] P.R.]

Vishnevskaya, N. S., and Nepenin, Y. N. 1973. [BLEACHING HARDWOOD SULPHATE PULP.] Bumazhnaya Promyshlennost' No. 10, 3-4. [Ru., NLL.]
Presents data on bleaching trials on pulp of Aspen and Birch, with comparative data for Pine pulps.

861.16

Domburg, G. E., and Gromov, V. S. 1965. DECOMPOSITION OF CARBOHYDRATES AND FORMATION OF FURFURAL UNDER THE CONDITIONS OF HYDROTROPIC COOKING OF HARDWOOD. Transl. U.S. For. Prod. Lab., Madison No. 641, pp. 11. [18 refs., 4 tbls.]
Transl. from Himiceskaja pererabotka i zascita drevesiny. Izdatelstvo Akademii Nauk Latvijskoj SSR, Riga. 1964. pp. 53-60. Not for publication.

862 COMPOSITE MATERIALS MADE WHOLLY OR PARTLY OF WOODY MATTER

Cernyseva, V. A., and Petri, V. N. 1968. [DECAY RESISTANCE OF LIGNOCARBOHYDRATE HOT-PRESSED SHEETS MADE FROM CHIPPED SPRUCE LOGGING SLASH AND BIRCH AND ASPEN SAWDUST.] Lesn. Z., Arhangelsk 11 (5): 89-91. [7 refs. [Ru.].]
Increasing the pressure from 25 to 50 kg./sq.cm. did not affect resistance, and it is concluded that the high decay resistance of the sheets is due primarily to changes in the chemical composition and structure of the wood components, and not to compaction, increased density and reduced m.c. as suggested elsewhere.

Danilov, V. V., and Petri, V. N. 1968. [HOT-PRESSED SHEETS MADE OF ASPEN SAWDUST WITHOUT THE ADDITION OF

BINDER.] Lesn. Z., Arhangelsk 11 (3): 91-2. [5 refs. [Ru.].]
The author recommends pressing at 180° C., with an initial m.c. of 16-18%. This optimum schedule will vary with the species of raw material.

Geimer, R. L., Heebink, B. G., and Hefty, F. V. 1973. WEATHERING CHARACTERISTICS OF PARTICLEBOARD. USDA Forest Service Research Paper, Forest Products Laboratory, Madison No. FPL 212, 21 pp. [E., 4 ref.]
Three-layer Aspen boards had the best anti-spring-back efficiency. Internal bond strengths were not affected by steam post-treatment.

Kehr, E. 1967. [ON PROCESS TECHNOLOGIES FOR THE MANUFACTURE OF PARTICLE BOARDS, PARTICULARLY THE INFLUENCE OF SOLID RESIN, HARDENER, AND WATER REPELLENT CONTENTS ON QUALITY.] Holztechnol., Dresden 8 (2): 81-6. [5 refs. [G.g.ru.e.] P.R.]
Describes tests with 1- or 3-layer boards of Scots Pine, Aspen, or Alder, on the effect of these factors, and density, on strength, sorption properties, and surface smoothness, and discusses the methods which are technologically or economically best for the achievement of the desired qualities.

Kylasov, A. B., and Petri, V. N. 1970. [EFFECT OF MOISTURE ON THE MECHANICAL PROPERTIES OF LIGNO-CELLULOSIC PLASTIC SHEETS MADE OF ASPEN PARTICLES.] Lesn. Z. 13 (5): 74-7. [Ru., 2 refs.]

Lhri, O. 1968. [RECENT DEVELOPMENTS IN PARTICLE BOARD.] Pap. ja Puu 50 (7): 403-18. [19 refs. [Fin.e.] P.R.]
Discusses increases in production and developments in techniques, etc. in Finland. Birch now comprises 70-75% of the raw material, and Alder and Aspen are also used.

Markevich, N. F. 1973. [PHYSICAL AND MECHANICAL PROPERTIES OF PARTICLE BOARDS FROM WOOD OF DIFFERENT SPECIES.] Derevoobrabatyvayushchaya Promyshlennost' No. 11, 3-4. [Ru., NLL].
Aspen boards consistently had the best and the Birch the poorest properties, though the differences were small. The results do not support the generally held opinion that Aspen chips require more binder than Birch or softwood chips.

Mikhailov, N. A., and Ostapenko, N. I. 1973. [THE DIMENSIONAL STABILITY OF PARTICLE BOARDS.] Derevoobrabatyvayushchaya Promyshlennost' No. 9, 4-5. [Ru., NLL].

Petri, V., Akkerman, A., et al. 1971. [PLASTICS [i.e. HOT-PRESSED SHEETS] MADE FROM WOOD OF BROADLEAVED SPECIES.] Lesn. Prom. (7), (14-5). [Ru.]
Aspen produced better boards than Birch and, with both species, boards made from wood containing up to 40% brown rot, white rot, or false heart were superior to boards made from sound wood. Mixtures of Aspen and Birch gave better boards than pure Birch, and here also the presence of rot improved the properties of the finished boards.

Scharai-rad, M. 1970. PRUFUNG DER EIGNUNG VON HOLZ VON POPULUS TREMULA, POPULUS CANESCENS UND SHOREA ZUR HERSTELLUNG ZEMENTGEBUNDENER HOLZWERKSTOFFE. Dipl. Arb. (Dipl. Holzwirt) Mathem. Naturwiss. Fak., Univ. Hamburg 52 S. [6 graph. Darst., 25 Tab., 27 Lit. Ang., dt.Zsfg.]

Staryh, A. M., and Koval, V. O. 1965. [A TRIAL OF MANUFACTURING EXTRUDED PARTICLE BOARDS FROM ASPEN WOOD.] Derev. Prom. 14 (12): 20-2. [Ru.] P.R.
Argues that Aspen wood, previously regarded as unsatisfactory for use in extruded-particle-board manufacture, gives good results if the particles are prepared correctly.

867 DESTRUCTIVE DISTILLATION

Galkin, V. A., Golubev, V. N., et al. 1970. [INVESTIGATION OF CHARCOALS OF VARIOUS SPECIES OF WOOD AS A RAW MATERIAL FOR PRODUCING ACTIVATED CARBONS.] Gidrol. lesohim. Prom. 23 (4): 18-9. [Ru., 2 refs., P.R.]
Charcoal of Populus tremula is not suitable for applications where the sorption properties of the material are important, e.g. in decolorizing.

89 OTHER FOREST PRODUCTS

892 VEGETABLE PRODUCTS

Alekseeva, E. A., Agranat, A. L., and Solodkij, F. T. 1970. [CHEMICAL COMPOSITION OF LIPIDS OF ASPEN BARK.] Gidrol. lesohim. Prom. 23 (5): 13-4. [Ru., 13 refs., P.R.]

Alekseeva, E. A., Pijalkin, V. N., et al. 1970. [COMPOSITION OF THE FATTY ACIDS OF THE LIPIDS OF ASPEN BARK.] Lesn. Z. 13 (6): 96-9. [Ru., 5 refs.]

Demchenko, E. A. 1974. [STUDY OF THE LIPIDS OF THE INNER AND OUTER BARK OF ASPEN.] Lesnoi Zhurnal 17 (6): 118-122. [Ru., 9 ref.]

Pearl, I. A., Darling, S. F., and Heller, S. F. 1966. GLUCOSIDES FROM THE BARKS AND LEAVES OF TRIPLOID VARIETIES OF POPULUS SPECIES. Tappi 49 (6): 278-80. [9 refs.]
Results suggest not only similar differences in triploid and other polyploid varieties of all Populus spp., but also substantial differences in other extractives of the leaves and barks, sapwood, heartwood etc.

Vysotskaya, I. F., and Korolkov, I. I. 1971. [THE CHEMICAL COMPOSITION OF SPRUCE AND ASPEN BARK.] Gidrol. lesokhim. Prom. 24 (7): 4-5. [Ru., 2 ref., NLL]

892.5

Anonymous. 1973. [UTILIZATION OF THE BIOLOGICALLY ACTIVE SUBSTANCES OF TREES.] Riga, USSR, Zinatne. 143 pp. [Ru.e., many ref., NLL]

Thieme, H., and Richter, R. 1966. [ISOLATION OF A NEW PHENOL GLYCOSIDE FROM POPULUS TREMULA.] Pharmazie, E. Berlin 21 (4): 251. [6 refs. [G.] E.M.B.]
In addition to salicin, salireposide and salicortin (a new report for this species), a new glycoside, for which the name tremulacin is proposed, was isolated from the bark and leaves. It was also found in bark and leaves of P. alba and P. trichocarpa, and in the bark of P. tremuloides.

Tomchuk, G. N., Grishchenko, A. V., Tand Tomchuk, R. I. 1972. [THE CAROTENE CONTENT OF LEAVES AND NEEDLES DURING STORAGE.] Lesnaya Promyshlennost' No. 11, 26-27. [Ru.]
The carotene content decreased with time, and more rapidly in the leaves of broadleaved species (Aspen, Beech, Birch, and Willow) than in the needles of conifers (Spruce and Silver Fir).

Usoltsev, V. A. 1973. [CONTENT OF CAROTENE AND ITS MAINTENANCE IN TWIGS AND FOLIAGE OF BIRCH AND ASPEN.] Lesnoe Khozyaistvo No. 10, 30-33. [Ru., 7 ref.]
Results indicate that the foliage can be stored in the forest for 4-10 days without a significant drop in carotene content. The carotene remains longer when the foliage is detached from the stem and stored in heaps. Wetting the foliage prolongs the period it can be kept.

9 FORESTS AND FORESTRY

FROM THE NATIONAL AND INTERNATIONAL POINTS OF VIEW

90 GENERAL

Fontnoire, J. 1973. [THE ASPEN.] Foret Privee Francaise No. 90 (59-66). [F.]
Briefly describes the botany, ecology, silvicultural characters and uses of Populus tremula.

U. N. Educational Scientific and Cultural Organization. 1964. LAND USE IN SEMI-ARID MEDITERRANEAN CLIMATES: UNESCO/INTERNATIONAL GEOGRAPHICAL UNION SYMPOSIUM, IRAKLION (GREECE), 12-26. SEPTEMBER 1962. Arid Zone Research, Unesco, Paris No. 26, pp. 170. Many refs. [E. or F.]

P. TREMULOIDES

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

11 SITE FACTORS: CLIMATE, SITUATION, SOIL, HYDROLOGY

111 THE ATMOSPHERE. METEOROLOGY. CLIMATE AND MICROCLIMATE

Miller, P. C. 1969. SOLAR RADIATION PROFILES IN OPENINGS IN CANOPIES OF ASPEN AND OAK. Science 164 (3877): 308-9. 5 refs., O.R.S.]
Measurements in stands of Populus tremuloides and Quercus ambelii in the summers of 1966-67 showed higher radiation values at some levels within the canopy than those found above the canopy for a proportion of the openings studied in Colorado, but not in Minnesota.

114 SOIL. SOIL SCIENCE

114.2

Alban, D. H. 1974. SOIL VARIATION AND SAMPLING INTENSITY UNDER RED PINE AND ASPEN IN MINNESOTA. USDA Forest Service Research Paper, North Central Forest Experiment Station No. NC-106, 10 pp. [E., 13 ref.]
Only two samples were needed to determine pH, bulk density and sand content of the surface or subsoil under both species, but 25 to 50 samples were needed to determine N, P, K, Ca, Mg, available water and silt + clays. Twice as many samples under Pine as under Aspen were needed for the forest floor.

McNulty, M. E., and Wullstein, L. H. 1969. SOIL NITROGEN TRANSFORMATIONS IN ASPEN AND CONIFER STANDS. Abstr. in Proc. Utah Acad. Sci. 46 (1): 189. [NLL]

Sanger, J. E. 1969. A QUANTITATIVE STUDY OF LEAF PIGMENTS FROM INITIATION IN BUDS TO DECOMPOSITION IN SOILS. Abstr. of thesis, in Dissert. Abstr. 29B (10): 3643-4. [O.R.S.]

Schnitzer, M., and Gupta, U. C. 1964. SOME CHEMICAL CHARACTERISTICS OF THE ORGANIC MATTER EXTRACTED FROM THE O AND B2 HORIZONS OF A GREY WOODED SOIL. Proc. Soil Sci. Soc. Amer. 28 (3): 374-7. 10 refs.

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Cleve, K. van, and Noonan, L. L. 1971. PHYSICAL AND CHEMICAL PROPERTIES OF THE FOREST FLOOR IN BIRCH AND ASPEN STANDS IN INTERIOR ALASKA. Proc. Soil Sci. Soc. Amer. 35 (2): 356-60. [16 refs.]
Describes a study of the mass and nutrient status of the forest floor of seven stands each of Populus tremuloides (a) and Betula papyrifera (b) of various ages in the Fairbanks area.

114.351

Cleve, K. van. 1971. ENERGY- AND WEIGHT-LOSS FUNCTIONS FOR DECOMPOSING FOLIAGE IN BIRCH AND ASPEN FORESTS IN INTERIOR ALASKA. Ecology 52 (4): 720-3. [12 ref.]

114.4

Lavkulich, L. M., Pawluk, S., and Odynsky, W. 1964. SOIL PROFILE DEVELOPMENT IN SOME PEACE RIVER SOILS. Canad. J. Soil Sci. 44 (2): 188-95. 16 refs. O.R.E.
Analyses three soils in N. Alberta under Populus tremuloides in an area with a history of forest burning. They are classified as orthic dark grey, dark grey wooded, and orthic grey wooded soils.

Rieger, S., and DeMent, J. A. 1965. CRYORTHODS OF THE COOK INLET-SUSITNA LOWLAND, ALASKA. Proc. Soil Sci. Soc. Amer. 29 (4): 448-53. 12 refs.

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Dash, M. C., and Cragg, J. B. 1972. ECOLOGY OF ENCHYTRAEIDAE (OLIGOCHAETA) IN CANADIAN ROCKY MOUNTAIN SOILS. Pedobiologia 12 (5): 323-335. [E.e., 22 ref., OZ]

Morrall, R. A. A. 1974. SOIL MICROFUNGI ASSOCIATED WITH ASPEN IN SASKATCHEWAN: SYNECOLOGY AND QUANTITATIVE ANALYSIS. Canadian Journal of Botany 52 (8): 1083-1817. [E.f., 46 ref., ORS]

Oliver, L. K. 1972. A STUDY OF MICROFUNGI ON FERTILIZER PLOTS IN A YOUNG ASPEN STAND. Master of Science Thesis, University of Alaska.

116 HYDROLOGY. WATER CONSERVATION, SOIL CONSERVATION AND EROSION

Brown, H. E., and Thompson, J. R. 1965. SUMMER WATER USE BY ASPEN, SPRUCE AND GRASSLAND IN WESTERN COLORADO. J. For. 63 (10): 756-60. 4 refs.

Gray, H. L. 1972. RIME CONTRIBUTES TO WATER BALANCE IN HIGH-ELEVATION ASPEN FORESTS. Journal of Forestry 70 (2): 93-97. [E., 5 ref.]

Haeffner, A. D., and Leaf, C. F. 1973. AREAL SNOW COVER OBSERVATIONS IN THE CENTRAL ROCKIES, COLORADO. USDA Forest Service General Technical Report, Rocky Mountain Forest and Range Experiment Station No. RM-5, 15 pp. [E., 16 ref.]
Hart, G. E., Schultz, J. D., and Coltharp, G. B. 1969. CONTROLLING TRANSPIRATION IN ASPEN WITH PHENYLMERCURIC ACETATE. Wat. Resour. Res., Wash. 5 (2): 407-12. [10 refs., O.R.S.]

Jeffrey, W. W. 1965. EXPERIMENTAL WATERSHEDS IN THE ROCKY MOUNTAINS, ALBERTA, CANADA. Repr. from Publication, International Association of Scientific Hydrology, Budapest No. 66, (502-21). 11 refs. [E.e.]

Johnson, R. S., and Doty, R. D. 1972. DESCRIPTION AND HYDROLOGIC ANALYSIS OF TWO SMALL WATERSHEDS IN UTAH'S WASATCH MOUNTAINS. USDA Forest Service Research Paper, Intermountain Forest and Range Experiment Station No. INT-127, 53 pp. [E., 18 ref.]

Johnston, R. S. 1969. ASPEN SPROUT PRODUCTION AND WATER USE. U.S. For. Serv. Res. Note Intermt. For. Range Exp. Sta. No. INT-89, pp. 6 [3 refs.]

Johnston, R. S. 1970. EVAPOTRANSPIRATION FROM BARE HERBACEOUS AND ASPEN PLOTS: A CHECK ON A FORMER STUDY. Wat. Resour. Res. 6 (1): 324-7. [5 refs., O.R.S.]
Further four-year observations, supported by moisture determinations to a depth of 9 ft. by means of a neutron moisture meter, confirmed the results reported earlier.

Johnston, R. S. 1971. RAINFALL INTERCEPTION IN A DENSE UTAH ASPEN CLONE. US For. Serv. Res. Note Intermt. For. Range Exp. Sta. No. INT-143, pp. 4. [10 ref.]
Interception by Populus tremuloides scrub forest and its herbaceous understorey at 8400 ft. alt. was 10·3% of total summer rainfall during 1962-65. The amounts involved (0·5 in/season) are considered unimportant. Aspen stemflow amounted to a further 1·4%.

Johnston, R. S., Tew, R. K., and Doty, R. D. 1969. SOIL MOISTURE DEPLETION AND ESTIMATED EVAPOTRANSPIRATION ON UTAH MOUNTAIN WATERSHEDS. U.S. For. Serv. Res. Pap. Intermt. For. Range Exp. Sta. No. INT-67, pp. 13. [7 refs.]

Swanson, R. H. 1970. LOCAL SNOW DISTRIBUTION IS NOT A FUNCTION OF LOCAL TOPOGRAPHY UNDER CONTINUOUS TREE COVER. Journal of Hydrology, New Zealand 9 (2): 292-298. [E.] From Meterological and Geoastrophysical Abstracts 22, 11-439. ORS.
Snow accumulation showed no relation to aspect, slope, altitude or crown closure that was significant in both months. Results agree with those of a study in the Marmot catchment, and suggest that general guidelines can be specified for managing these cover types for increased water yield, without regard to topography.

Tew, R. K. 1967. SOIL MOISTURE DEPLETION BY ASPEN IN CENTRAL UTAH. U.S. For. Serv. Res. Note Intermt. For. Range Exp. Sta. No. INT-73, pp. 8. [1 ref.]
Aspect and elevation of site and age of vegetation affect the amount of soil moisture depleted by Populus tremuloides during the growing season. Clones on W. aspects used more moisture than those on either N. or S. slopes. Differences in elevation had little effect on the amount of moisture used.

Urie, D. H. 1966. AN ANALYSIS OF THE HYDROLOGIC BUDGET IN GLACIAL SANDS UNDER PINE AND HARDWOOD FORESTS. Abstr. of thesis, in Dissert. Abstr. 26 (8): 4149-50. [O.R.S.]

116.13

Marston, R. B. 1966. 116.13: 187x4 (792): 114.1. SOME COMPARATIVE HYDROLOGIC CHARACTERISTICS OF ASPEN AND MOUNTAIN BRUSH COMMUNITIES ON STEEP MOUNTAIN WATERSHEDS IN NORTHERN UTAH. Abstr. of thesis, in Dissert. Abstr. 26 (10): 5630.

14 SYSTEMATIC ZOOLOGY

Hill, D. C., Evans, E. V., and Lumsden, H. G. 1968. METABOLIZABLE ENERGY OF ASPEN FLOWER BUDS FOR CAPTIVE RUFFED GROUSE. J. Wildlife Mgmt. 32 (4): 854-8. [7 refs., Smry., 1 fig., 3 tbls.]
Under experimental conditions flower buds of Populus tremuloides proved to have a low metabolizable energy content for the grouse (Bonasa umbellus) – little better than pure cellulose.

Reynolds, H. G. 1969. ASPEN GROVE USE BY DEER, ELK, AND CATTLE IN SOUTHWESTERN CONIFEROUS FORESTS. U.S. For. Serv. Res. Note Rocky Mt. For. Range Exp. Sta. No. RM-138, pp. 4.
Aspen groves yielded ca. 6 times more under-storey herbaceous plants than adjacent mixed conifer forests.

Smith, C. F. 1974. THE GENUS PHLOEMYZUS WITH THE DESCRIPTION OF P. DEARBORNI N. SP. FROM POPULUS TREMULOIDES MICHX. (HOMOPTERA: APHIDIDAE). Proceedings of the Entomological Society of Washington 76 (1): 66-72. [E., 12 ref., From Review of Applied Entomology, A 63, 2895.]

15 ANIMAL ECOLOGY

Abell, D. H., and Gilbert, F. F. 1974. NUTRIENT CONTENT OF FERTILIZED DEER BROWSE IN MAINE. Journal of Wildlife Management 38 (3): 517-524. [E., 15 ref., OZ]

Blouch, R. I. 1964. THE RESPONSE OF DEER TO A FOREST WILDLIFE MANAGEMENT PROGRAM ON THE MID FOREST LODGE. Abstr. of thesis, in Dissert. Abstr. 25 (2): 727-8. O.R.S.
A study of white-tailed deer on an area of 28 sq. miles was made over 4 years to assess the effect of a managed Aspen harvest. Results show an increase in buck kill and hunter success, a greater kill in Aspen than in Oak and a consistently higher kill in cut-over areas.

Dealy, J. E. 1971. HABITAT CHARACTERISTICS OF THE SILVER LAKE MULE DEER RANGE. USDA Forest Service Research Paper, Pacific Northwest Forest and Range Experiment Station No. PNW-125, 99 pp. [E., 21 ref.]

Hungerford, C. R. 1970. RESPONSE OF KAIBAH MULE DEER TO MANAGEMENT OF SUMMER RANGE. J. Wildlife Mgmt. 34 (4): 852-62. [10 refs., N.L.L.]
Of the tree species browsed, Aspen suffered most heavily, and mature foliage was preferred.

Patton, D. R., and Avant, H. D. 1970. FIRE STIMULATED ASPE SPROUTING IN A SPRUCE-FIR FOREST IN NEW MEXICO. U.S For. Serv. Res. Note Rocky Mt. For. Range Exp. Sta. No. RM-15 pp. 3. [5 refs.]
Data from a burned area in the Spruce/Fir type indicate th burning significantly increased density of Populus tremuloides f ca. 4 years. After that, the number of stems/acre declined and t Aspen began to grow out of reach as browse for elk [wapiti] an deer.

Peek, J. M. 1972. MOOSE HABITAT SELECTION AND REL TIONSHIPS TO FOREST MANAGEMENT IN NORTHEASTER MINNESOTA. [Abstract]. Dissertation Abstracts International, 32 (11): 6149. [E., ORS, Order No. 72-14,352.]
It is concluded that the future of the moose population depends o the methods of timber management employed, especially f Populus tremuloides, and within the Boundary Waters Canoe Are on the restoration of wildlife or its equivalent into the ecosystem.

Peek, J. M., Kreeting, L. W., and Tappeiner, J. C. 1971. VARI TION IN TWIG DIAMETER-WEIGHT RELATIONSHIPS I NORTHERN MINNESOTA. J. Wildlife Mgmt. 35 (3): 501-7. [1 ref., NLL]

Shafer, E. L., Jr. 1963. THE TWIG-COUNT METHOD FO MEASURING HARDWOOD DEER BROWSE. J. Wildlife Mgm 27 (3): 428-37. 10 refs. B.A.P.
This method converts a twig count to weight by using an avera weight per twig for individual species. It is nearly as quick as t weight-estimation method, and the results can be analyse statistically.

Stevens, D. R. 1970. WINTER ECOLOGY OF MOOSE IN TH GALLATIN MOUNTAINS, MONTANA. J. Wildlife Mgmt. 34 (1 37-46. [23 ref., NLL]
Discusses the role of Populus tremuloides in Pseudotsuga menzie vegetation types in the provision of browse.

Byelich, J. D., Cook, J. L., and Blouch, R. I. 1972. MANAGEMEN FOR DEER. In Aspen: symposium Proceedings. Northcent. Fo Exp. Stn., St. Paul, Minn. 154 p.

16 GENERAL BOTANY

160 PLANT CHEMISTRY

Comtat, J., Joseleau, J. P., Bosso, C., and Barnoud, F. 197 CHARACTERIZATION OF STRUCTURALLY SIMILA NEUTRAL AND ACIDIC TETRASACCHARIDES OBTAINE FROM THE ENZYMIC HYDROLYZATE OF A 4-0 METHYL-l GLUCURONO-D-XYLAN. Carbohydr. Res. 38: 217-224. Ref.

Haissig, B. E., and Schipper, A. L. 1972. EASY EXTRACTION O ENZYMES FROM SMALL AMOUNTS OF WOODY TISSUE. An Biochem. 48 (1): 129-146. Ref.

Harkin, J. M., and Obst, J. R. INTERACTIONS BETWEEN LIGNI AND CELLULOSE IN ORGANIC LIQUID AND SALIN DENSITY GRADIENT COLUMNS. Wood Fibre 5 (4): 343-34 Ref.

Hicks, R. R., and Stairs, G. R. 1973. BIOCHEMICAL CO PARISONS OF EXTRACTS FROM PHYSIOLOGICALL JUVENILE AND MATURE QUAKING ASPEN CUTTINGS. Pro Northeast. For. Tree Improv. Conf. 20th: 17-27.

Kinsley, H. B., Jr. 1967. A STUDY OF THE COMPONENTS O THE LEAD SUBACETATE PRECIPITATE OF THE LEAVES O POPULUS TREMULOIDES. Abstr. of thesis, in Dissert. Abst 28B (2): 581. [O.R.S.] [Cf. F.A. 29 No. 89.]

Kinsley, H., Jr., and Pearl, I. A. 1967. STUDIES ON THE LEAVE OF THE FAMILY SALICACEAE. IX. COMPONENTS OF TH LEAD SUBACETATE-INSOLUBLE FRACTION OF POPULU TREMULOIDES LEAVES. Tappi 50 (8): 419-23. [25 refs.]
Upon alkaline hydrolysis, the Pb-subacetate-insoluble fractic yielded vanillic acid, p-coumaric acid, p-hydroxybenzoic aci ferulic acid, and salicyl alcohol.

Pearl, I. A., and Darling, S. F. 1967. STUDIES ON THE LEAVE OF THE FAMILY SALICACEAE. VIII. FURTHER STUDIES O

THE LEAVES OF TRIPLOID POPULUS TREMULOIDES *Tappi 50 (4): 193-5. [7 refs.]
[Cf. F.A. 28 Nos. 1584-5.] Pyrocatechol, tremuloidin, salireposide (not previously found in Poplar leaves) and triploside (a new glucoside) were isolated from P. tremuloides leaves. Analysis indicated that triploside is a monoacetate of salicin 2-benzoate.

Schier, G. A., and Johnston, R. S. 1971. CLONAL VARIATION IN TOTAL NONSTRUCTURAL CARBOHYDRATES OF TREMBLING ASPEN ROOTS IN THREE UTAH AREAS. Canad. J. For. Res. 1 (4): 252-5. [E.f., 11 ref.]

Tew, R. K. 1970. SEASONAL VARIATION IN THE NUTRIENT CONTENT OF ASPEN FOLIAGE. J. Wildlife Mgmt. 34 (2): 475-8. [10 refs., N.L.L.]
Contents of Ca, Mg, Na and fat increased as the season progressed, while total N, P, and K decreased significantly. Protein content varied greatly between stands, but was higher in young leaves than in old leaves from all stands. Browse quality therefore undergoes seasonal changes.

Young, H. E., Carpenter, P. N., and Altenberger, R. A. 1965. PRELIMINARY TABLES OF SOME CHEMICAL ELEMENTS IN SEVEN TREE SPECIES IN MAINE. Tech. Bull. Me. Agric. Exp. Sta. No. 20, pp. 88. 6 refs.

160.2

Mathes, M. C., Helton, E. D., and Fisher, K. D. 1971. THE PRODUCTION OF MICROBIAL-REGULATORY MATERIALS BY ISOLATED ASPEN [POPULUS TREMULOIDES] TISSUE. Plant and Cell Physiology 12, (593-601).

161 PHYSIOLOGY

Bate, G. C., and Canvin, D. T. 1971. THE EFFECT OF SOME ENVIRONMENTAL FACTORS ON THE GROWTH OF YOUNG ASPEN TREES (POPULUS TREMULOIDES) IN CONTROLLED ENVIRONMENTS. Canad. J. Bot. 49 (8): 1443-53. [32 ref.]

Botanical Society of America. 1966. PROGRAM WITH ABSTRACTS OF PAPERS TO BE PRESENTED AT THE MEETINGS OF THE BOTANICAL SOCIETY OF AMERICA AND CERTAIN AFFILIATED GROUPS AT THE UNIVERSITY OF MARYLAND, COLLEGE PARK, AUGUST 14-18, 1966. Amer. J. Bot. 53 (6, Part 2): 603-43. O.B.D.
Effect of phloem blocks on cambial activity of Populus tremuloides (T. T. Kozlowski and R. F. Evert.)

Foote, K. C., and Schaedle, M. 1973. SEASONAL AND DIURNAL FIELD RATES OF PHOTOSYNTHESIS AND RESPIRATION IN STEMS OF POPULUS TREMULOIDES MICHX. [Abstract]. American Journal of Botany 60 (4): 24. [E., OBD.]
It was shown that in all assays, the rate of respiration in darkness exceeded the rate of stem photosynthesis. Diurnal assays showed that corticular photosynthesis reduced the loss respiratory CO_2 by 1 to 36.5%, depending on the intensity of incoming radiation.

Hicks, R. R., Jr. 1972. THE ASPEN ROOTING TEST: A NEW BIOASSAY. Forest Science 18 (1): 21-22. [E., 4 ref.]

Levengood, W. C. 1973. BIOELECTRIC CURRENTS AND OXIDANT LEVELS IN PLANT SYSTEMS. Journal of Experimental Botany 24 (81): 626-639 + 1 pl. [E., 10 ref., OBD.]

Miller, P. C. 1967. LEAF ORIENTATION AND ENERGY EXCHANGE. Abstr. in Bull. Ecol. Soc. Amer. 48 (2): 55. [A.P.B.]

Sauter, J. J. 1972. RESPIRATORY AND PHOSPHATASE ACTIVITIES IN CONTACT CELLS OF WOOD RAYS AND THEIR POSSIBLE ROLE IN SUGAR SECRETION. Zeitschrift fur Pflanzenphysiologie 67 (2): 135-145. [E., 41 ref., OBD.]
The activity of succinate, NAD-dependent isocitrate and alcohol dehydrogenases, and of acid phosphatases was studied cytochemically in wood rays of Betula populifolia and Populus tremuloides in late winter and spring.

Schaedle, M., Iannaccone, P., and Foote, K. C. 1968. HILL REACTION CAPACITY OF ISOLATED QUAKING ASPEN BARK CHLOROPLASTS. For. Sci. 14 (2): 222-3. [5 refs.]
Chloroplasts were isolated from the bark of Populus tremuloides. The isolated organelles were able to reduce 2,6-dichlorophenolindophenol at a rate similar to other plant systems. The total photosynthetic reducing activity of the bark of two trees was found to be 3·8 and 12·1% of that of their leaves.

161.32

Schaedle, M., and Foote, K. C. 1971. SEASONAL CHANGES IN THE PHOTOSYNTHETIC CAPACITY OF POPULUS TREMULOIDES BARK. For. Sci. 17 (3): 308-13. [22 ref.]

164 MORPHOLOGY

Hicks, R. R., Jr., and Gladstone, W. T. 1971. SOME ANATOMICAL ASPECTS OF ROOTING QUAKING ASPEN. In Proceedings, 11th Conference on Southern Forest Tree Improvement, 265-274. [E., 8 ref.]
It was concluded that reduced rooting in physiologically mature P. tremuloides stem cuttings was due to an inability to form primordia rather than to the mechanical restriction of roots by thick-walled cells. [Cf. FA 32, 158.]

Maini, J. S., and Coupland, R. T. 1964. ANOMALOUS FLORAL ORGANIZATION IN POPULUS TREMULOIDES. Canad. J. Bot. 42 (7): 835-9. 9 refs. O.R.S.
The abnormal stems had fewer capsules in each inflorescence. Bisexual flowers had heavier seeds. Germination tests showed no differences in seed viability, and seedlings from monoecious tree seed appeared to be normal.

165 PHYLOGENY, EVOLUTION. HEREDITY, GENETICS AND BREEDING, VARIATION

Green, K. A., Zasada, J. C., and Cleve, K. van. 1971. AN ALBINO ASPEN SUCKER. For. Sci. 17 (2): 272. [3 ref.]

165.3/.7

Andrejak, G. E., and Barnes, B. V. 1969. A SEEDLING POPULATION OF ASPENS IN SOUTHEASTERN MICHIGAN. Michigan Botanist, Ann Arbor 8 (4): 189-202. [35 refs., N.L.L.]

Barnes, B. V. 1967. INDICATIONS OF POSSIBLE MIDCENOZOIC HYBRIDIZATION IN THE ASPENS OF THE COLUMBIA PLATEAU. Rhodora 69 (777): 70-81. [20 refs., O.B.D.]
A hypothesis based on leaf dimensions and tooth number.

Barnes, B. V. 1969. NATURAL VARIATION AND DELINEATION OF CLONES OF POPULUS TREMULOIDES AND P. GRANDIDENTATA IN NORTHERN LOWER MICHIGAN. Silvae Genet. 18 (4): 130-42. [62 refs. [E.e.].]

Einspahr, D. W., and Benson, M. K. 1964. PRODUCTION AND EVALUATION OF ASPEN HYBRIDS. J. For. 62 (11): 806-9. 5 refs.
Describes hybridization techniques and experimental crosses of 13 parentages attempted within Populus section Leuce, in N. Wisconsin.

Einspahr, D. W. 1965. COLCHICINE TREATMENT OF NEWLY FORMED EMBRYOS OF QUAKING ASPEN. For. Sci. 11 (4): 456-9. 12 refs.

Einspahr, D. W. 1968. ESTIMATED GENETIC GAINS FOR QUAKING ASPEN. Genet. Physiol. Note Inst. Paper Chem., Appleton, Wis. No. 3, pp. 6. [8 refs.]

Einspahr, D. W., Benson, M. R., and Peckham, J. R. 1967. VARIATION AND HERITABILITY OF WOOD AND GROWTH CHARACTERISTICS OF FIVE-YEAR-OLD QUAKING ASPEN. Genet. Physiol. Note Inst. Paper Chem., Appleton, Wis. No. 1, pp. 6. [5 refs.]
The survival, growth, and wood and pulp properties of 25 full-sib families of Populus tremuloides were studied in Wisconsin.

Every, A. D., and Wiens, D. 1971. TRIPLOIDY IN UTAH ASPEN. Madrono 21 (3): 138-147. [E., 24 ref., OBD.]
In 18 populations of Populus tremuloides from Utah, all were diploid except three triploids and one apparent tetraploid. Because of the small sample studied, however, this apparently high proportion of polyploidy may be misleading.

Greene, J. G. 1972. CLONAL VARIATION IN POPULUS TREMULOIDES MICHX. ON THE EAST SLOPE OF THE FRONT RANGE, BOULDER COUNTY, COLORADO [USA]. [Abstract]. Dissertation Abstracts International, B 32 (7): 3784-3785. [E., ORS, Order No. 72-3655.]
Reports a study of 20 clones on a transect from 1670 to 3430 m. alt., and 30 clones on relatively uniform sites at ca. 2800 m alt., over the period 1967-1970. Results showed much inter-clonal variation, particularly in phenology.

Maini, J. S. 1968. VARIATION IN THE GROWTH AND REPRODUCTION OF WIDELY DISTRIBUTED POPULUS TREMULOIDES MICHX. (ASPEN). Abstr. in Bull. Ecol. Soc. Amer. 49 (2): 71. [A.P.B.]

Stairs, G. R. 1966. THE EFFECTS OF IONIZING RADIATION ON THE GENETIC STRUCTURE OF HETEROZYGOUS OUTBREEDING POPULATIONS OF FOREST TREES. Prog. Rep. June 1, 1965 to May 31, 1966. Contract AT (30-1)-35-71: Dep. Mn. CFSTI. pp. 9. [From abstr. in Plant Breed. Abstr. 1968 38 (4): No. 6984.]
Male flower buds irradiated at 〉 500 R show severe cytological damage, and it is suggested that, for mutation breeding purposes, radiations be kept below this level.

Strain, B. R. 1964. PHYSIOLOGICAL AND MORPHOLOGICAL VARIABILITY OF LOCAL QUAKING ASPEN CLONES. Abstr. of thesis, in Dissert. Abstr. 25 (6): 3228. O.R.S.
Studies of differentiation between local variant biotypes, representing the total range of population variability in the White Mountains and the Virginia Creek Area of the Sierra Nevada, were made on 8 clones of Populus tremuloides. Studies of the sites included measurements of soil and air temperatures, evaporation, precipitation, soil moisture, profile. Measurements indicated a direct correlation between severity of habitat and growth form of Aspen ramets. It is concluded that local ecotypic differentiation has occurred in Aspen in S.E. Califomia.

Valentine, F. A., LaBumbard, S., and Fowler, R. G. 1969. SELECTION AND IDENTIFICATION OF MONOPLOID POPULUS TREMULOIDES MICHX. Proc. 16th Ntheast. For. Tree Impr. Conf., Quebec 1968, (29-34). [7 refs.]

Valentine, F. A., and Manion, P. D. 1972. GENETIC CONTROL OF SUSCEPTIBILITY TO HYPOXYLON MAMMATUM IN NATIVE ASPENS. In Proceedings, 19th Northeastern Forest Tree Improvement Conference, 1971, 97-108. [E., 9 ref.]

Winton, L. L. 1968. SQUASH PREPARATIONS FOR COUNTING ASPEN CHROMOSOMES. Genet. Physiol. Note Inst. Paper Chem., Appleton, Wis. No. 5, pp. 5. [14 refs. Smry.]
Describes improved techniques for facilitating the counting of chromosomes in leaves of Populus [tremuloides].

168 HISTOLOGY

Blackwell, S. J., Laetsch, W. M., and Hyde, B. B. 1969. DEVELOPMENT OF CHLOROPLAST FINE STRUCTURE IN ASPEN TISSUE CULTURE. Amer. J. Bot. 56 (4): 457-63. [24 refs., Smry., 11 figs.]
A study of chloroplast ontogeny in 42-day etiolated triploid Populus tremuloides callus subjected to two different light conditions.

Mathes, M. C. 1964. THE CULTURE OF ISOLATED TRIPLOID ASPEN TISSUE. For. Sci. 10 (1), (35-8). 5 refs.
Satisfactory growth was obtained when a medium containing NAA was supplemented with 100 p.p.m. of casamino acids or malt extract. The growth rate increased with increasing temperature from 25 to 30° C.

Mathes, M. C., and Einspahr, D. W. 1965. COMPARISON OF TREE GROWTH AND CALLUS PRODUCTION IN ASPEN. For. Sci. 11 (3): 360-3. 5 refs.

Winton, L. L. 1968. PLANTLETS FROM ASPEN TISSUE CULTURES. Science 160 (3833): 1234-5. [13 refs., O.R.S.]
Leafy shoots were initiated on cultures of callus tissue of Populus tremuloides, on Wolter's medium without auxin and with 6-benzylaminopurine at 0·05, 0·10, 0·15 or 0·20 mg./litre substituted for kinetin, after two weeks in the dark. These shoots transferred to Wolter's medium in the light grew large roots and have been isolated as plantlets.

Winton, L. L. 1968. THE ROOTING OF LIQUID-GROWN ASPEN CALLUS. Amer. J. Bot. 55 (2): 159-67. [22 refs. O.B.D.]

Wolter, K. E. 1964. IN VITRO CULTIVATION OF ASH, ASPEN AND PIN OAK CALLUS TISSUE. Abstr. of thesis, in Dissert. Abstr. 24 (12, part I): 4895. O.R.S.
Gives details of the synthetic media found satisfactory for the continuous growth in subcultures of Fraxinus pennsylvanica, Populus tremuloides and Quercus palustris, for a period of 3 years.

Wolter, K. E. 1968. ROOT AND SHOOT INITIATION IN ASPEN CALLUS CULTURES. Nature, Lond. 219 (5153): 509-10. [6 refs.]
Examines the specific content of cytokinins and auxins necessary for organogenesis in callus cultures of Populus tremuloides.

Wolter, K. E., and Gordon, J. C. 1972. HORMONAL CONTROL OF GROWTH AND LIGNIFICATION IN ASPEN CULTURES IN RELATION TO PEROXIDASE LEVEL AND ISOENZYME EXPRESSION. [Abstract]. Plant Physiology 49 (Supplement) 32. [E., OBD.]
Initial experiments in which tissue cultures of Populus tremuloides were subjected to three hormonal treatments (auxin, cytokinin or auxin + cytokinin) showed that peroxidase activity per gram of tissue dry weight was highly correlated with growth rate and degree of lignification.

17 SYSTEMATIC BOTANY

Webster, R. K., and Butler, E. E.1967. A MORPHOLOGICAL AND BIOLOGICAL CONCEPT OF THE SPECIES CERATOCYSTIS FIMBRIATA. Canad. J. Bot. 45 (9): 1457-68 + 53 photos). [37 refs., O.R.S.]

Bella, I. E., and Jarvis, J. M. 1967. HIGH TOTAL PRODUCTIVITY OF A YOUNG ASPEN STAND IN MANITOBA. Pulp Paper Mag. Can. 68 (10): WR 432, WR 437. [3 refs., 1 tbl.]

Burkart, L., and Hossfeld, R. 1967. THE EFFECT OF NaSH – NaOH COOKING LIQUOR ON THE HEMICELLULOSES OF ASPEN WOOD. Svensk PappTidn. 70 (8): 265-7. [12 refs. [E.e.sw.g.] 1 tbl.]

Pronin, D., and Vaughan, C. L. 1967. A LITERATURE SURVEY OF POPULUS SPP. WITH EMPHASIS ON P. TREMULOIDES. U.S. For. Serv. Res. Note U.S. For. Prod. Lab., Madison No. FPL-0180, pp. 30. [306 refs.]
A bibliography of world literature since 1940 arranged alphabetically by authors under each of the headings: Production and supply; Tension wood; Properties; Density; Harvesting and processing; Silviculture; Growth; Utilization; Genetics; Pulp and paper; Chemistry; General; and Disease and insects (119 refs.).

Shoup, J. M., Nairn, L. D., and Pratt, R. H. M. 1968. TREMBLING ASPEN BIBLIOGRAPHY. Liais. Serv. Note For. Res. Lab., Winnipeg No. MS-L-3, pp. 81. [Many refs.]
The bibliography of Populus tremuloides is presented in two sections: (1) a subject listing by O.D.C., and (2) a list in alphabetical order of authors.

18 PLANT ECOLOGY

181 MODE OF LIFE, AUTECOLOGY. SILVICULTURAL CHARACTERS OF TREES

Jones, J. R. 1973. ROCKY MOUNTAIN ASPEN. U.S., Dept. of Agriculture. USDA Agr. Handb. 445: 49-51. Ref.

Morgan, M. D. 1969. ECOLOGY OF ASPEN IN GUNNISON COUNTY, COLORADO. Amer. Midl. Nat. 82 (1): 204-28. [47 refs. B.A.P.]

181.2

Loach, K. 1967. SHADE TOLERANCE IN TREE SEEDLINGS. I. LEAF PHOTOSYNTHESIS AND RESPIRATION IN PLANTS RAISED UNDER ARTIFICIAL SHADE. New Phytol. 66 (4): 607-21. [41 refs., O.R.S.]

Loach, K. 1970. SHADE TOLERANCE IN TREE SEEDLINGS. II. GROWTH ANALYSIS OF PLANTS RAISED UNDER ARTIFICIAL SHADE. New Phytol. 69 (2): 273-86. [20 refs., O.R.S.]

181.213

Freyman, S. 1968. SPECTRAL DISTRIBUTION OF LIGHT IN FORESTS OF THE DOUGLAS FIR ZONE OF SOUTHERN BRITISH COLUMBIA. Canad. J. Pl. Sci. 48 (3): 326-8. [4 refs., 1 graph., 1 tbl.]

181.3

Eubanks, J. O. 1971. EFFECT OF LIGHT INTENSITY AND OSMOTIC STRESS ON THE WATER RELATIONS OF POPULUS TREMULOIDES. For. Sci. 17 (1): 79-82. [16 ref.]
Results showed that plants grown at 3600 ft-candles were able to grow better at higher moisture stress than plants grown at 900 ft-candles.

181.31

Eubanks, J. O. 1970. THE EFFECT OF LIGHT INTENSITY AND OSMOTIC WATER STRESS ON THE WATER POTENTIAL OF POPULUS TREMULOIDES. Abstr. of thesis, in Dissert. Abstr. int. 30B (11): 4864-5.
Results suggest that both reduced cell turgor pressure and the assumed factor of reduced photosynthesis may be directly related to the inability of P. tremuloides to grow and develop in the shade of other trees.

McQueen, I. S., and Miller, R. F. 1972. SOIL-MOISTURE AND ENERGY RELATIONSHIPS ASSOCIATED WITH RIPARIAN VEGETATION NEAR SAN CARLOS, ARIZONA. Professional Paper, United States Geological Survey No. 655-E, 51 pp. [E.] From Meteorological and Geoastrophysical Abstracts 24, 6-352. ORS.

181.32/.34

Dormaar, J. F. 1971. PROLONGED LEACHING OF ORTHIC BLACK Ah MATERIAL WITH WATER AND AQUEOUS EXTRACTS OF POPULUS TREMULOIDES AND P. BALSAMIFERA LEAVES. J. Soil Sci. 22 (3): 350-8. [24 ref.]

Tew, R. K. 1968. PROPERTIES OF SOIL UNDER ASPEN AND HERB-SHRUB COVER. U.S. For. Serv. Res. Note Intermt. For. Range Exp. Sta. No. INT-78, pp. 4. [1 ref.]

181.35

Bailey, A. W., and Gupta, R. K. 1973. GRASS-WOODY PLANT RELATIONSHIPS. Canadian Journal of Plant Science 53 (3): 671-676. [E.f., 12 ref., ORE.]

Krywolap, G. N., Grand, L. F., and Casida, L. E., Jr. 1964. THE NATURAL OCCURRENCE OF AN ANTIBIOTIC IN THE MYCORRHIZAL FUNGUS CENOCOCCUM GRANIFORME. Canad. J. Microbiol. 10 (3): 323-8. 6 refs. O.R.S.

181.36

DeByle, N. V. 1964. DETECTION OF FUNCTIONAL INTRACLONAL ASPEN ROOT CONNECTIONS BY TRACERS AND EXCAVATION. For. Sci. 10 (4): 386-96. 9 refs.

Gifford, G. G. 1966. ASPEN ROOT STUDIES ON THREE SITES IN NORTHERN UTAH. Amer. Midl. Nat. 75 (1): 132-41. 17 refs. B.A.P.

Lyford, W. H., and Wilson, B. F. 1966. CONTROLLED GROWTH OF FOREST TREE ROOTS: TECHNIQUE AND APPLICATION. Harv. For. Pap. No. 16, pp. 12. [8 refs.]
When woody roots of species such as Acer rubrum, Quercus borealis, Pinus strobus and Populus tremuloides are severed, new roots will be produced near the cut surface on the part nearest the stem, so long as this portion is kept moist. The new roots (still attached to the tree) can be grown in shallow trays in soil or other media, and manipulated under controlled conditions for physiological studies.

Tew, R. K., DeByle, N. V., and Schultz, J. D. 1969. INTRACLONAL ROOT CONNECTIONS AMONG QUAKING ASPEN TREES. Ecology 50 (5): 920-1. [4 refs.]
Three tracer solutions applied to 46 Populus tremuloides clones in northern Utah revealed numerous examples in which many stems (maximum 43) were connected on a common root system. The greatest lateral distance between a 'donor' and 'receptor' tree was 16·9 m. The number of connected stems was not related to the % of sand, gravel or clay in the soil, or to soil bulk density or elevation of the site.

181.4

Bella, I. E. 1969. COMPETITIVE INFLUENCE-ZONE OVERLAP: A COMPETITION MODEL FOR INDIVIDUAL TREES. Bi-m. Res. Notes, Ottawa 25 (3): 24-5. [6 refs.]

Bella, I. E. 1971. A NEW COMPETITION MODEL FOR INDIVIDUAL TREES. For. Sci. 17 (3): 364-72. [13 ref.]

Loope, L. L., Gruell, G. E. 1973. THE ECOLOGICAL ROLE OF FIRE IN THE JACKSON HOLE AREA, NORTHWESTERN WYOMING. Quaternary Research 3, 425-443. [E., 47 ref.] From Berichte Biochemie und Biologie (1974) 396, 403. De. Reinbek.

Martinovic, B. S. 1969. [INTERACTION OF SPRUCE AND ASPEN WHEN GROWN TOGETHER.] In Botaniceskie Issledovanija. Vol. 11. Minsk. pp. 195-9. [[Ru.] From abstr. in Referat. Z., Moskva (8.56.77). [Ru.] N.L.L.]
Aspen litter neither inhibited nor stimulated growth of Spruce.

Martinovich, B. S. 1971. [CHARACTERISTICS OF THE PHOTOSYNTHESIS OF SPRUCE AND ASPEN IN PURE AND MIXED STANDS.] In Fitotsenoticheskie Issledovaniia v Belorussii, P. 151-159. Ref. [Ru.]

181.5

Avanzo, E. 1970. [THE SEX RATIO AND RELATIONS BETWEEN CERTAIN CHARACTERS AND SEX IN PROGENY OF POPULUS TREMULOIDES.] Bull. Serv. Cult. Etud. Peuplier et Saule (45-50). [F., 21 ref.]

Blake, G. M., Hossfeld, R. L., and Pauley, S. S. 1967. MORE ON THE DETERMINATION OF SEX FROM THE VEGETATIVE BUDS OF ASPEN. For. Sci. 13 (1): 89. [1 ref.]

Fechner, G. H. 1972. DEVELOPMENT OF THE PISTILLATE FLOWER OF POPULUS TREMULOIDES FOLLOWING CONTROLLED POLLINATION. Canadian Journal of Botany 50 (12): 2503-2509. [E.f., 5 ref., ORS.]

Jones, J. R. 1974. ASPEN SUCKER GROWING FROM AN ENGELMANN SPRUCE STUMP. USDA Forest Service Research Note, Rocky Mountain Forest and Range Experiment Station No. RM-264, 2 pp. [E., 7 ref.]

Maini, J. S. 1968. THE RELATIONSHIP BETWEEN THE ORIGIN OF ADVENTITIOUS BUDS AND THE ORIENTATION OF POPULUS TREMULOIDES ROOT CUTTINGS. Abstr. in Bull. Ecol. Soc. Amer. 49 (2): 81-2. [A.P.B.]

Sauer, J., and Struik, G. 1964. A POSSIBLE ECOLOGICAL RELATION BETWEEN SOIL DISTURBANCE, LIGHTFLASH, AND SEED GERMINATION. Ecology 45 (4): 884-6. 18 refs.
A connexion is suggested between germination of certain seeds (a) under field conditions after soil disturbance, and (b) in laboratory experiments after brief exposure to light.

Schier, G. A. 1973. EFFECT OF ABSCISIC ACID ON SUCKER DEVELOPMENT AND CALLUS FORMATION ON EXCISED ROOTS OF POPULUS TREMULOIDES. Physiologia Plantarum 28 (1): 143-145. [E., 11 ref.]
Abscisic acid (ABA) inhibited the development of suckers and promoted the formation of callus on excised roots of Populus tremuloides. Clonal differences in the inhibition of sucker formation in response to ABA appeared to be related to the developmental stage of the pre-existing shoot primordia. When treatment with ABA was followed about a month later by treatment with gibberellic acid, the inhibitory effect of ABA was partly reversed.

Schier, G. A. 1973. EFFECTS OF GIBBERELLIC ACID AND AN INHIBITOR OF GIBBERELLIN ACTION ON SUCKERING FROM ASPEN ROOT CUTTINGS. Canadian Journal of Forest Research 3 (1): 39-44. [E.f., 19 ref.]

Schier, G. A. 1973. ORIGIN AND DEVELOPMENT OF ASPEN ROOT SUCKERS. Canadian Journal of Forest Research 3 (1): 45-53. [E.f., 26 ref.]

Describes a study showing that adventitious shoots (suckers) originate from the roots of Populus tremuloides from newly initiated meristems, pre-existing primordia, or suppressed short shoots, the first two probably being the most important in sucker production.

Schier, G. A. 1973. SEASONAL VARIATION IN SUCKER PRODUCTION FROM EXCISED ROOTS OF POPULUS TREMULOIDES AND THE ROLE OF ENDOGENOUS AUXIN. Canadian Journal of Forest Research 3 (3): 459-461. [E.f., 7 ref.]
Seasonal variation in the number of suckers produced from root cuttings of three clones of P. tremuloides from Utah was inversely correlated with the endogenous auxin content of the roots at the time of collection. The mean number of suckers per cutting varied with the clone of origin and the date of collection.

Steneker, G. A. 1973. SIZE AND SUCKERING OF TREMBLING ASPEN (POPULUS TREMULOIDES MICHAUX) CLONES IN MANITOBA. [Abstract]. Dissertation Abstracts International, B 33 (9): 4064-4065. [E., ORS, Order No. 73-6924.]

Steneker, G. A. 1973. THE SIZE OF TREMBLING ASPEN (POPULUS TREMULOIDES MICHX.) CLONES IN MANITOBA. Canadian Journal of Forest Research 3 (4): 472-478. [E.f., 18 ref.]

Steneker, G. A. 1974. FACTORS AFFECTING THE SUCKERING OF TREMBLING ASPEN. Forestry Chronicle 50 (1): 32-34. [E.f., 9 ref.]
Field experiments (described) in a 12-year-old stand of Populus tremuloides in Manitoba suggest that apical dominance of the tree crowns is the primary factor controlling the production of suckers and that only when this dominance is broken will suckering be promoted by higher soil temperatures.

Steneker, G. A., and Prasad, R. 1972. SUCKERING AND SOLUBLE SUGARS IN TREMBLING ASPEN ROOT CUTTINGS. Bi-Monthly Research Notes 28 (5): 34. [E.]
The soluble-sugar concentrations in the roots appear to decrease significantly from early spring to late summer, and may account for up to 50% of the variation in sucker growth.

Tew, R. K. 1968. ROLE OF ZINC, CARBOHYDRATE RESERVES, AND SOIL PROPERTIES IN THE VEGETATIVE REPRODUCTION OF ASPEN. Abstr. of thesis, in Dissert. Abstr. 29B (5): 1540. [O.R.S.]

Tew, R. K. 1970. ROOT CARBOHYDRATE RESERVES IN VEGETATIVE REPRODUCTION OF ASPEN. For. Sci. 16 (3): 318-20. [9 refs.]

181.521

Valentine, F. A. 1974. GENETIC CONTROL OF SEX RATIO, EARLINESS AND FREQUENCY OF FLOWERING IN POPULUS TREMULOIDES. In Proceedings, 22nd Northeastern Forest Tree Improvement Conference 1975 (111-129). [E., 12 ref.]
Study of flowering in 36 families derived from controlled pollination of P. tremuloides from 15 natural stands in New York.

181.6

International Union of Forest Research Organizations. 1971. FOREST BIOMASS STUDIES. WORKING GROUP ON FOREST BIOMASS STUDIES. SECTION 25. GROWTH AND YIELD. INTERNATIONAL UNION OF FOREST RESEARCH ORGANIZATIONS. XVth IUFRO CONGRESS, UNIVERSITY OF FLORIDA, GAINESVILLE, FLORIDA, USA. MARCH 15-20, 1971. Life Sciences and Agriculture Experiment Station, University of Maine, Orono. pp. 240. [Many ref.]
Comprises 16 papers presented at the Congress Biomass sampling methods for Alder/Willow/Aspen/Birch/Red Maple stands of Maine, USA (H.E. Young; 6 ref.); dry weight and leaf area of Aspen [Populus tremuloides/P. grandidentata] trees in northern Wisconsin (J. Zavitkovski; 14 ref.).

Jones, J. R. 1971. AN EXPERIMENT IN MODELING ROCKY MOUNTAIN FOREST ECOSYSTEMS. US For. Serv. Res. Pap. Rocky Mt. For. Range Exp. Sta. No. RM-75, pp. 19. [44 ref.]
Despite the unsuitability of clonal Aspen stands as a test of the prototype model, the mode of construction illustrates the problems encountered in, and some possible methods useful for, constructing models of ecosystems.

Perala, D. A. 1973. STAND EQUATIONS FOR ESTIMATING AERIAL BIOMASS, NET PRODUCTIVITY, AND STEM SURVIVAL OF YOUNG ASPEN SUCKERS ON GOOD SITES. Canadian Journal of Forest Research 3 (2): 288-292. [E.f., 10 ref.]
Data were collected in Populus tremuloides stands, 1-23 years old, in N.-central Minnesota, over a period of 12 years, by destructive sampling of biomass in 12 stands.

Peterson, E. B., Chan, Y. H., and Cragg, J. B. 1970. ABOVE-GROUND STANDING CROP, LEAF AREA, AND CALORIFIC VALUE IN AN ASPEN CLONE NEAR CALGARY, ALBERTA. Canad. J. Bot. 48 (8): 1459-69. [28 refs., O.R.S.]
Study made of 49 ramets of a single clone of Populus tremuloides. The above-ground biomass in the portion sampled was 77·11 metric tons/ha., representing an accumulation of 3630 X 10^8 g. cal./ha., of which 84·3% was in the stems, 13·5% in the branches and 2·2% in the foliage.

Pollard, D. F. W. 1970. EFFECT OF PARTIAL DEFOLIATION ON LEADER GROWTH. Bi-m. Res. Notes 26 (2): 10-1. [5 refs.]
Experiments in the second and third growing seasons on seedlings of Populus tremuloides, initially one year old, indicated that height growth and weight of leaders was unaffected by partial defoliation of the plant.

Pollard, D. F. W. 1971. MORTALITY AND ANNUAL CHANGES IN DISTRIBUTION OF ABOVE-GROUND BIOMASS IN AN ASPEN SUCKER STAND. Canad. J. For. Res. 1 (4), (262-6). [E.f., 9 ref.]

Pollard, D. F. W. 1972. ABOVE-GROUND DRY MATTER PRODUCTION IN THREE STANDS OF TREMBLING ASPEN. Canadian Journal of Forest Research 2 (1): 27-33. [E.f., 23 ref.]

Pollard, D. F. W. 1972. ESTIMATING WOODY DRY MATTER LOSS RESULTING FROM DEFOLIATION. Forest Science 18 (2): 135-138. [E., 8 ref.]

182 SYNECOLOGY, PLANT SOCIOLOGY

182.2

Crowther, E. G., and Harper, K. T. 1965. VEGETATIONAL AND EDAPHIC CHARACTERISTICS ASSOCIATED WITH ASPEN 'STRIPS' IN BIG COTTONWOOD CANYON [SOUTHEAST OF SALT LAKE CITY]. Proc. Utah Acad. Sci. 42 (2), (222-30). [12 refs. N.L.L.]
Vegetational and soil data are presented where deep soil is occupied by Aspen and the shallow soils support shrubby Oak and other mountain species.

Jones, G. J., and Peterson, E. B. 1970. PLANT SPECIES DIVERSITY IN A WOODLAND/MEADOW ECOTONE NEAR REGINA, SASKATCHEWAN. Canad. J. Bot. 48 (3), (591-601). [23 refs. O.R.S.]

Sidhu, S. S. 1973. EARLY EFFECTS OF BURNING AND LOGGING IN PINE-MIXEDWOODS. I. FREQUENCY AND BIOMASS OF MINOR VEGETATION. Information Report, Petawawa Forest Experiment Station, Canada No. PS-X-46, 47 pp. [E., 15 ref.]
Describes early quantitative changes in the frequency and biomass of minor plant species after partial logging and prescribed burning. Populus tremuloides were apparently favoured by burning.

182.48

Sheard, J. W. and Jonescu, M. E. 1974. A MULTIVARIATE ANALYSIS OF THE DISTRIBUTION OF LICHENS ON POPULUS TREMULOIDES IN WEST-CENTRAL CANADA. Bryologist 77 (4): 514-530. Ref.

182.5

Groenewoud, H. van, and Ihm, P. 1974. A CLUSTER ANALYSIS BASED ON GRAPH THEORY. Vegetatio 29 (2) 115-120 [E., 11 ref. BLL]
Clustering method that groups plots on the basis of their proximity in a multidimensional test space in which the axes represent species. The method is demonstrated for sample plots in mixed Picea glauca

tands (with Populus tremuloides) in N. Saskatchewan for which 31 abitat variables were measured.

187 VEGETATION TYPES

lexander, R. R. 1974. SILVICULTURE OF CENTRAL AND OUTHERN ROCKY MOUNTAIN FORESTS: A SUMMARY OF HE STATUS OF OUR KNOWLEDGE BY TIMBER TYPES. JSDA Forest Service Research Paper, Rocky Mountain Forest and ange Experiment Station No. RM-120, 36 pp. [E., 4 ref.]
ncludes habitat conditions, successional relations, stand conditions, lamaging agents, natural regeneration and early survival, site quality nd growth and yield.

louin, J.-L., and Grandtner, M. M. 1965. [AN ECOLOGICAL TUDY OF THE ASPEN STANDS OF THE LOWER SAINT AWRENCE.] Abstr. in Ann. ACFAS 1963/1964 31, (41). [F.]

espain, D. G. 1973. VEGETATION OF THE BIG HORN MOUNAINS, WYOMING, IN RELATION TO SUBSTRATE AND LIMATE. Ecological Monographs 43 (3) 329-355 [E., 94 ref.]
opulus tremuloides is present but unimportant as a vegetation ype.

rew, L. A. 1974. SOME SYNECOLOGICAL CHARACTERISTICS F THE PRAIRIE-FOREST TRANSITION ZONE IN MINNEOTA. Minnesota Forestry Research Notes No. 250, 3 pp. [E., 3 ef.]
pecies composition and stand characteristics were determined here Populus tremuloides was commonest in the north west.

ylis, N. V. [Editor.] 1971. [BIOGEOCOENOLOGICAL INVESTIGATIONS IN BROADLEAVED/SPRUCE FORESTS.] Izdatel'stvo auka, Moscow. pp. 333. [Ru., many ref. NLL]
collection of 9 research papers on broadleaved/Spruce forests in he Moscow region.

ralish, J. S. 1968. THE INFLUENCE OF SOIL TEXTURE ON HE AMOUNT OF SUGAR MAPLE PRESENT IN THE ASPEN TANDS OF NORTHERN WISCONSIN. From abstr. in Bull. Ecol. oc. Amer. 49 (2), (79).
tands growing on soils containing < 18% silt-plus-clay had no Acer accharum, while stands on soils having > 68% had a maximum umber in the lower strata.

agnon, G., and Grandtner, M. M. 1973. [ECOLOGY AND DYAMICS OF THE POPULUS TREMULOIDES COMMUNITIES OF HE LAURENTIAN SECTION.] Memoire, Service de la Recherche, irection Generale des Forets, Ministere des Terres et Forets du uebec No. 14, xvi + 131 pp. + 5 tab. [F.e., 93 ref.]
escribes the principal P. tremuloides communities in the aurentian section of the Great Lakes and analyses the predominant cological factors responsible for the present distribution of plant ommunities.

ones, J. R. 1974. SILVICULTURE OF SOUTHWESTERN MIXED ONIFERS AND ASPEN: THE STATUS OF OUR KNOWLEDGE. JSDA Forest Service Research Paper, Rocky Mountain Forest and ange Experiment Station No. RM-122, 44 pp. [E., 6 pp. of ref.]

oyal, R. 1970. [DESCRIPTION OF THE MER BLEUE PEAT BOG EAR OTTAWA. I. VEGETATION.] Canad. J. Bot. 1970 48 (7), 1405-18 + 1 photo). [F.e., 23 refs. O.R.S.]

night, D. H. 1964. AN ANALYSIS OF WISCONSIN FOREST EGETATION ON THE BASIS OF PLANT FUNCTION AND ROSS MORPHOLOGY. Abstr. of thesis, in Dissert. Abstr. 25 (4), 2189-90). O.R.S.
rees, shrubs and herbs were examined for structural and functional nethod of seed dispersal for fire resistance features.

Lopoukhine, N. 1970. FOREST TYPES AND RELATED VEGETATION OF WATERTON LAKES NATIONAL PARK, ALBERTA, 1968. Inform. Rep. For. Mgmt. Inst., Ottawa No. FMR-X-28, pp. [83]. [E.F., 15 refs.]
Describes the physical features and vegetation of this Park, which ranges from 4180 to 9050 ft. in altitude.

Newsome, R. D. 1966. A PHYTOSOCIOLOGICAL STUDY OF THE FORESTS OF THE CYPRESS HILLS. Abstr. of thesis, in Dissert. Abstr. 27B (5), (1379). [O.R.S.]
Analysis of phytosociological data from stands which lie across the Alberta/Saskatchewan border, led to construction of a site index incorporating stand density and an environmental index based on moisture availability.

Ohmann, L. F., Cushwa, C. T., Lake, R. E., Beer, J. R., and Brander, R. B. 1973. WILDERNESS ECOLOGY: THE UPLAND PLANT COMMUNITIES, WOODY BROWSE PRODUCTION, AND SMALL MAMMALS OF TWO ADJACENT 33-YEAR-OLD WILDFIRE AREAS OF NORTHEASTERN MINNESOTA. USDA Forest Service General Technical Report, North Central Forest Experiment Station No. NC-7, 30 pp. [E., 49 ref.]
Four types of plant community were identified: Populus tremuloides/Betula papyrifera, B. papyrifera, Pinus banksiana/B. papyrifera, and P. banksiana. There was no significant difference in total browse production between the four types of community.

Oswald, E. T. 1968. A SYNECOLOGICAL STUDY OF THE FORESTED MORAINES OF THE VALLEY FLOOR OF GRAND TETON NATIONAL PARK, WYOMING. Abstr. of thesis, in Dissert. Abstr. 28B (7), (2740). [O.R.S.]
The main tree species were Pinus contorta, Abies lasiocarpa, Pseudotsuga menziesii and Populus tremuloides. Community classification, successional features, and forest pathology in relation to succession are discussed.

Payette, S., and Lavoie, V. 1971. [SOIL/VEGETATION RELATIONS IN THE LOWER PERIBONKA REGION. I. THE PLANT COMMUNITIES.] Nat. canad. 98 (3), (495-514 + 6 tbls.). [F.e., 15 ref. NLL]
Data are given on the species composition and soil characters of the principal plant communities.

Reed, R. M. 1971. ASPEN FORESTS OF THE WIND RIVER MOUNTAINS, WYOMING. Amer. Midl. Nat. 86 (2), (327-43). [29 ref. OZ]
A study of successional status, resulting in the recognition of one stable Aspen community. Quantitative data are given on stand structure, undergrowth species, soils and topography.

Swan, J. M. A., and Dix, R. L. 1966. THE PHYTOSOCIOLOGICAL STRUCTURE OF UPLAND FOREST AT CANDLE LAKE, SASKATCHEWAN. J. Ecol. 54 (1), (13-40). 39 refs.

Wall, M. K., and Krajina, V. J. 1973. VEGETATION-ENVIRONMENT RELATIONSHIPS OF SOME SUB-BOREAL SPRUCE ZONE ECOSYSTEMS IN BRITISH COLUMBIA. Vegetatio 26 (4/6) 237-381 + 2 tab. [E., 264 ref. APB]
Vegetation analyses, soil classifications and soil chemical analyses were made.

Walker, B. H., and Coupland, R. T. 1970. HERBACEOUS WETLAND VEGETATION IN THE ASPEN GROVE AND GRASSLAND REGIONS OF SASKATCHEWAN. Canad. J. Bot. 48 (10), (1861-78). [37 refs. O.R.S.]
Presents data on species frequency, environmental gradients and vegetation groups and analysed by the association analysis technique.

2 SILVICULTURE

arvis, J. M., et al. 1966. REVIEW OF SILVICULTURAL RESEARCH, WHITE SPRUCE [PICEA GLAUCA] AND TREMBLING ASPEN [POPULUS TREMULOIDES] COVER TYPES, MIXEDWOOD FOREST SECTION, BOREAL FOREST REGION, ALBERTA-SASKATCHEWAN-MANITOBA. Publ. Dep. For. Can. No. 1156, pp. 189. [Many refs.]
Brings together data on all research projects undertaken by the Department of Forestry in this field.

22 SILVICULTURAL SYSTEMS. CONSTITUTION AND COMPOSITION OF STANDS; FORMS OF STAND

Brinkman, K. A. 1973. LAKE STATES ASPEN. POPULUS, SILVICULTURE. U.S. Dept. of Agriculture. U.S.D.A. Agr. Handb. 445: 64-66.

Person, R. A., Hallgren, A. R., and Hubbard, J. W. 1971. YIELDS FROM SHORT-ROTATION ASPEN SUCKERS. Minn. For. Res. Note No. 224, pp. 4. [1 ref.]
A study of dry-weight yields of Populus tremuloides suckers up to 12 years old on sample areas in N. Minnesota with the possibility of growing sucker crops on very short rotations. Data on moisture %, green and dry weight %s, and diameter, height and green weight of suckers aged 2-12 years are tabulated.

Alder, G. M., and Harper, K. T. 1969. AGE PROFILES IN ASPEN FORESTS OF UTAH AND NORTHERN ARIZONA. Abstr. in Proc. Utah Acad. Sci. 46 (2), (166). [NLL]
Data were collected from 44 stands on a variety of sites on stocking, height, diameter, and age, and counts were made of big-game- and sheep-pellet groups. Stand-age profiles for Populus tremuloides show the detrimental effects of heavy grazing by both sheep and deer.

23 REGENERATION AND FORMATION OF STANDS

231 NATURAL REGENERATION

Bella, I. E., and DeFranceschi, J. P. 1972. THE EFFECT OF LOGGING PRACTICES ON THE DEVELOPMENT OF NEW ASPEN STANDS, HUDSON BAY, SASKATCHEWAN. Information Report, Northern Forest Research Centre, Canada No. NOR-X-33, 20 pp. [E., 9 ref.]
Stands of P. tremuloides were clear felled and harvested by either whole-stem or whole-tree logging. It is concluded that neither slash conditions nor season of logging is critical for adequate regeneration of P. tremuloides in this area.

Bjorkbom, J. C. 1972. STAND CHANGES IN THE FIRST 10 YEARS AFTER SEEDBED PREPARATION FOR PAPER BIRCH. USDA Forest Service Research Paper, Northeastern Forest Experiment Station No. NE-238, 10 pp. [E., 16 ref.]
Seed-tree cuttings were made in winter and summer in a 70-year-old mixed broadleaved/coniferous stand to favour natural regeneration of B. papyrifera, and after the winter cutting some plots were disked or burned. After 5 years, considerably more B. papyrifera regeneration was present on the disked and burned plots, but after 10 years the differences in number of B. papyrifera seedlings between treatments were relatively small.

Gauvin, G. 1964. REGENERATION STUDY IN 1955 BURN ON THE Q.N.S. PAPER COMPANY LIMITS [IN QUEBEC]. Pulp Paper Mag. Can. 65 (11), (WR452-WR453).
Gives observations on 5 plots. P. tremuloides and Betula papyrifera predominate; regeneration of Abies balsamea and Picea mariana is patchy.

MacArthur, J. D. 1964. A STUDY OF REGENERATION AFTER FIRE IN THE GASPE REGION. Publ. Dep. For. Can. No. 1074, pp. 20. 8 refs. [E.e.f.]
Stocking of spruce and balsam fir, 20 years after a burn was still inadequate on 50% of the area. Growth of the two species was about equal, and better than on cut-over land.

Perala, D. A. 1971. ASPEN SUCCESSFULLY REGENERATED AFTER KILLING RESIDUAL VEGETATION WITH HERBICIDES. US For. Serv. Res. Note Nth. Cent. For. Exp. Sta. No. NC-106, pp. 2. [1 ref.]
Unmerchantable species in a mixed hardwood stand in N. Minnesota, from which Populus tremuloides had been harvested, were controlled by aerial spraying of 3 lb/acre 2,4-D or 2,4,5-T + 2,4-D, without permanent damage to Aspen suckers.

Perala, D. A. 1972. REGENERATION: BIOTIC AND SILVICULTURAL FACTORS. In Aspen Symp. Proc. U.S. Dep. Agric. For. Serv. Gen. Tech. Rep. NC-1, 97-102.

Schier, G. A. 1972. APICAL DOMINANCE IN MULTISHOOT CULTURES FROM ASPEN ROOTS. Forest Science 18 (2) 147-149 [E., 6 ref.]
Removal of apices from suckers on P. tremuloides root cuttings either prevented the establishment of apical dominance or reduced its effects, and increased the number of sucker apices produced.

Schier, G. A., and Zasada, J. C. 1973. ROLE OF CARBOHYDRATE RESERVES IN THE DEVELOPMENT OF ROOT SUCKERS IN POPULUS TREMULOIDES. Canadian Journal of Forest Research 3 (2) 243-250 [E.f., 18 ref.]
Seasonal variation in sucker production in darkness in relation to the concentration of total non-structural carbohydrates was investigated in root cuttings of three clones of P. tremuloides.

Sorensen, R. W. 1968. SIZE OF ASPEN CROP TREES LITTLE AFFECTED BY INITIAL SUCKER DENSITY. U.S. For. Serv. Res. Note Nth. Cent. For. Exp. Sta. No. NC-51, pp. 4. [1 ref.]
A natural P. tremuloides sucker stand (one year old) was thinned to 500, 1000 and 1500 stems/acre (10,060 stems in the control). After clear felling on a good site an initial stocking of 1000 to 10,000 stems/acre will give an adequate number and size of crop trees at 15 years without thinning.

Ward, W. W. 1966. OAK/HARDWOOD REPRODUCTION IN CENTRAL PENNSYLVANIA. J. For. 64 (11), (744-9). [7 refs.]

Zasada, J. C., and Schier, G. A. 1973. ASPEN ROOT SUCKERING IN ALASKA: EFFECT OF CLONE, COLLECTION DATE, AND TEMPERATURE. Northwest Science 47 (2) 100-104 [E., 12 ref.]
A study was made of initial sucker development on excised roots from three Alaskan clones as affected by date of collection, clone, and temperature.

231.5

Steneker, G. A., and Walters, M. A. 1971. THE EFFECT OF ROOT LENGTH UPON THE SUCKERING OF TREMBLING ASPEN. POPULUS TREMULOIDES. Forest Res. Lab Edmonton Alberta Inf. Rep. Z-X 46, 11 p.

232 ARTIFICIAL REGENERATION

232.11

MacArthur, J. D. 1964. FIELD PLANTING TRIALS IN THE CLAY BELT – QUEBEC. Pulp Paper Mag. Can. 65 (Convention No.), (WR58-WR61). 4 refs. [E.e.f.]
Early results from trials of species and planting methods indicate that after one and two growing seasons respectively P. glauca and P. abies planted under a light canopy of Populus tremuloides had excellent survival and health.

232.2

Benson, M. K., and Einspahr, D. W. 1964. CHEMICAL CONTROL OF VEGETATIVE COMPETITION IN ASPEN PLANTINGS. Tree Plant. Notes No. 67, (15-7). 2 refs.
Tests were made of the application of weedkillers to the soil before planting 1-year P. tremuloides seedlings.

Jarvis, J. M., and Tucker, R. E. 1968. DROUGHT INDEX AS A PREDICTOR OF MOISTURE CONTENT IN L AND F HORIZONS ON AN UPLAND WHITE SPRUCE – TREMBLING ASPEN CUT-OVER AREA. Dep. Publ. For. Br. Can. No. 1237, pp. 10. [13 refs. [E.e.f.].]
This report shows the relationship between the moisture content of L and F horizons and drought index, for three distinct habitats on fresh sites. It is concluded that prescribed burning alone is not a satisfactory method for preparing mixed-wood clear-felled areas for planting or sowing with conifers.

Jarvis, J. M., and Tucker, R. E. 1968. PRESCRIBED BURNING AFTER BARREL-SCARIFYING ON A WHITE SPRUCE-TREMBLING ASPEN CUTOVER. Pulp Paper Mag. Can. 69 (21, Nov. 1), (70-2). [3 refs.]
Trials are reported in which burning was preceded by scarifying with water-filled barrels fitted with external fins and drawn by a crawler tractor.

Perala, D. A. 1971. CONTROLLING HAZEL, ASPEN SUCKERS, AND MOUNTAIN MAPLE WITH PICLORAM. US Forest Service Research Note, North Central Forest Experiment Station No. NS-129, 4 pp. [E., 4 ref.]
Applications of Tordon 101 made in Minnesota by either (a) mist blowing or (b) simulated aerial spraying.

Perala, D. A., and Williams, C. S. 1970. SITE PREPARATION FOR CONIFERS USING HERBICIDES AND SUBSEQUENT BURNING IN A NORTHERN MINNESOTA HARDWOOD STAND. Down to Earth 26 (3) 5-8 [E., 8 ref.] OW.
Summer spraying with Tordon 101, followed by prescribed burning in the next spring, effectively prepared a cut-over area with an

verstorey (70 ft2 b.a./acre of unmerchantable Populus tremuloides nd other broadleaved species) for planting with conifers.

232.315

Benson, M. K., and Harder, M. L. 1972. STORAGE OF ASPEN EED. Genet. Physiol. Note Inst. Paper Chem. No. 11, pp. 4. [1 ef.]
Results of a storage test of seeds of P. canescens, P. grandidentata nd P. tremuloides were stored for 1-4 years (a) at 4-4° C and (b) at 24°, and concludes that storage in (b) gave the best germination, specially of seed stored for > 2 years.

232.32

Benson, M. K., and Dubey, D. 1972. ASPEN SEEDLING PRODUCTION IN A COMMERCIAL NURSERY. Genet. Physiol. Note nst. Paper Chem. No. 12, pp. 7. [1 ref.]
Describes a method of raising seedlings of P. grandidentata, P. remuloides and Aspen hybrids.

232.328

Barry, W. J., and Sachs, R. M. 1968. VEGETATIVE PROPAGATION OF QUAKING ASPEN. Calif. Agric. 22 (1), (14-6). E.M.B.]
Best method of commercial propagation of P. tremuloides may be o place root segments 3-18 in. long and 1/8-2 in. in diam. in ermiculite, in Jan.-June, and to take cuttings from the shoots that rise from the numerous adventitious buds.

Gifford, G. F. 1967. THE INFLUENCE OF GROWTH MEDIA, TEMPERATURES, AND LIGHT INTENSITIES ON ASPEN ROOT AND TOP GROWTH. U.S. For. Serv. Res. Note Intermt. For. Range Exp. Sta. No. INT-67, pp. 4. [3 refs.]
Cuttings were grown in three soils, at two light intensities and three emperatures.

Maini, J. S., and Horton, K. W. 1966. VEGETATIVE PROPAGATION OF POPULUS SPP. (1) INFLUENCE OF TEMPERATURE ON FORMATION AND INITIAL GROWTH OF ASPEN SUCKERS]. Repr. from Canad. J. Bot. 44 (1183-9). [24 refs. E.e.f.] 2 gphs. 1 tbl.]

Schier, G. A. 1974. VEGETATIVE PROPAGATION OF ASPEN: CLONAL VARIATION IN SUCKERING FROM ROOT CUTTINGS AND IN ROOTING OF SUCKER CUTTINGS. Canadian Journal of Forest Research 4 (4) 565-567 [E.f., 11 ref.]
In a study of nine Populus tremuloides clones from Wyoming, large differences between clones were found in the production of suckers from root cuttings and in the rooting of green-wood stem cuttings taken from root suckers.

Starr, G. H. 1971. PROPAGATION OF ASPEN TREES FROM LATERAL ROOTS. J. For. 69 (12), (866-7).
Describes greenhouse experiments with cuttings from lateral roots collected monthly from June to Sept.

Winton, L. L. 1970. INITIATION OF FIRM WHITE ASPEN CALLUS UNDER DIFFERENT LIGHT ENVIRONMENTS. Phyton, Argentina 27 (1), (11-4). [E., 6 ref. EMB]
Roots of a triploid clone of P. tremuloides were planted in the greenhouse. In a period of 6 weeks the greatest amount of firm white callus was produced in total darkness. With increasing light intensities, growth was increasingly inhibited, though with 300 ft-candles and a 16-hour day, the callus turned green and red and produced leafy shoots.

Winton, L. L. 1970. SHOOT AND TREE PRODUCTION FROM ASPEN TISSUE CULTURES. Amer. J. Bot. 57 (8), (904-9). [25 ref. OBD]
Describes the production of plants from firm, white callus tissue of triploid Populus deltoides, initiated on a modified Wolter and Skoog medium.

232.329

Soos, J. 1967. FIRST YEAR MORTALITY OF CONTAINER PLANTING IN THE CLEARWATER-ROCKY MOUNTAIN HOUSE FOREST, ALBERTA. Inform. Rep. For. Res. Lab., Calgary No. A-X-7, pp. 42. [13 refs.]

235 UNDERPLANTING, ADVANCE PLANTING, ETC. NURSES AND FORMATION OF MIXTURES

Clements, J. R. 1966. DEVELOPMENT OF A WHITE PINE UNDERPLANTATION IN THINNED AND UNTHINNED ASPEN. For. Chron. 42 (3), (244-50). [6 refs. [E.e.f.].]
In 1936, part of a dense 12-year-old Populus tremuloides sucker stand was thinned, and part was left unthinned. In 1937, the entire stand was underplanted with 2 + 2 Pinus strobus. Pine mortality was high, partly as a result of vigorous hardwood competition, and it is concluded that successful underplanting cannot be secured without control of the understorey.

237 AMELIORATION OF FOREST SITES

Brouzes, R., Lasik, J., and Knowles, R. 1969. THE EFFECT OF ORGANIC AMENDMENT, WATER CONTENT, AND OXYGEN ON THE INCORPORATION OF $^{15}N_2$ BY SOME AGRICULTURAL AND FOREST SOILS. Canad. J. Microbiol. 15 (8), (899-905). [23 refs. O.R.S.]

Cleve, K. van. 1973. SHORT-TERM GROWTH RESPONSE TO FERTILIZATION IN YOUNG QUAKING ASPEN. Journal of Forestry 71 (12) 758-759 [E., 4 ref.]
In Alaska, a 15-year-old stand of P. tremuloides was subjected to a factorial fertilizer trial.

24 TENDING OF STANDS AND TREES

Schlaegel, B. E., and Ringold, S. B. 1971. THINNING POLE-SIZED ASPEN HAS NO EFFECT ON NUMBER OF VENEER TREES OR TOTAL YIELD. US For. Serv. Res. Note Nth. Cent. For. Exp. Sta. No. NC-121, pp. 2.
Briefly summarizes the effect of thinning from below a productive 37-year-old stand of Populus tremuloides in Minnesota, at age 47 years. Thinning is not recommended for stands nearing rotation age.

Steneker, G. A. 1964. TEN-YEAR RESULTS OF THINNING 14-, 19- AND 23-YEAR-OLD ASPEN TO DIFFERENT SPACINGS. Publ. Dep. For. Can. No. 1038, pp. 22. 9 refs. [E.e.f.]
Ten-year results of thinning in P. tremuloides stands in Manitoba, indicate that thinning to 12 X 12 ft. produced the greatest bd. ft. volume and will shorten by 10 years the rotation necessary for production of veneer bolts.

Steneker, G. A., and Jarvis, J. M. 1966. THINNING IN TREMBLING ASPEN STANDS: MANITOBA AND SASKATCHEWAN. Publ. Dep. For. Can. No. 1140, pp. 28. [17 refs. [E.e.f.].]
Thinning schedules were established for natural stands of Populus tremuloides.

Day, M. W. 1964. THE EFFECTIVENESS OF SEVERAL CHEMICALS AND METHODS FOR KILLING CULL TREES. Quart. Bull. Mich. Agric. Exp. Sta. 46 (3), (407-11).
Chemical formulations of 2,4-D and 2,4,5-T were applied to aspen, red maple, white pine and alder. Concentrated 2,4-D amine gave good results with aspen. Red maple needed full-strength 2,4,5-T amine or concentrated ester in edge-to-edge cuts. All methods gave 100% kill of Alder. White Pine was somewhat more resistant than Aspen.

Day, M. W. 1965. CACODYLIC ACID AS A SILVICIDE. Quart. Bull. Mich. Agric. Exp. Sta. 47 (3), (383-6).
Presents interim data from U.S. experiments on the effects after 1 and 2 years of Ansar 138 and 160 applied by frilling and injection, mainly on red maple, aspen and paper birch. Cacodylic acid showed considerable promise, although some sprouting occurred.

Lees, J. C. 1966. RELEASE OF WHITE SPRUCE FROM ASPEN COMPETITION IN ALBERTA'S SPRUCE-ASPEN FOREST. Publ. Dep. For. Can. No. 1163, pp. 16. 10 refs. [E.e.f.]

Smith, R. W. 1967. PROGRESS REPORT ON CACODYLIC ACID AS A SILVICIDE. Proc. 20th Ntheast. Weed Control Conf. 1966 (568-73). [3 refs. From abstr. in Weed Abstr. 16 (4), (No. 1288). O.W.]
Observations in 1965 after injection treatment in Aug. 1964 of several tree species with Ansar 160, a neutral 30% solution of cacodylic acid, showed that this was very effective against diffuse-porous species.

Steneker, G. A. 1967. GROWTH OF WHITE SPRUCE FOLLOWING RELEASE FROM TREMBLING ASPEN. Publ. For. Dep. Can. No. 1183, pp. v + 16. [9 refs. [E.e.f.] 1 dgm. 5 gphs. 2 tbls. 1 map.]

26 COMBINATIONS OF FORESTRY WITH AGRICULTURE

Bailey, A. W., and Wroe, R. A. 1974. ASPEN INVASION IN A PORTION OF THE ALBERTA PARKLANDS. Journal of Range Management 27 (4) 263-266 [E., 13 ref. BLL]
Study consisted of a comparison of survey records for 1907 with aerial photos taken in 1966, and tree-ring analyses on P. tremuloids stems and measurements of annual herbage production.

Hilton, J. E., and Bailey, A. W. 1972. CATTLE USE OF A SPRAYED ASPEN PARKLAND RANGE. Journal of Range Management 25 (4) 257-260 [E., 13 ref.] From Weed Abstracts 22, 2015. OW.
Forest and grassland range in central Alberta was treated with 2,4-D to control P. tremuloides.

Hilton, J. E., and Bailey, A. W. 1974. FORAGE PRODUCTION AND UTILIZATION IN A SPRAYED ASPEN FOREST IN ALBERTA. Journal of Range Management 27 (5) 375-380 [E., 10 ref. BLL]
Report giving separate data (by species) for forest stands of large aspen, forest margins of small aspen, and open grassland, either unsprayed or aerially sprayed with 2,4,-D.

Kranz, J. J. and Linder, R. L. 1973. VALUE OF BLACK HILLS FOREST COMMUNITIES TO DEER AND CATTLE. Journal of Range Management 26 (4) 263-265 [E., 12 ref.] From Herbage Abstracts 44, 1522.
A study of annual dry-matter production of forage from shrubs, forbs and grasses.

Pringle, W. L., Elliot, C. R., and Dobb, J. L. 1973. ASPEN REGROWTH IN PASTURES OF THE PEACE RIVER REGION. Journal of Range Management 26 (4) 260-262 [E., 6 ref.] From Weed Abstracts 23, 1009. OW.
There is no rapid inexpensive cultural method to convert an Aspen forest into a permanent productive pasture in this part of Alberta.

3 WORK SCIENCE. HARVESTING OF WOOD: LOGGING AND TRANSPORT. FOREST ENGINEERING

31 LOGGING AND TRANSPORT: GENERAL

Zasada, Z. A., and Tappeiner, J. C. 1969. FULL-TREE HARVESTING SYSTEM AIDS FOREST MANAGEMENT. Minn. For. Res. Note No. 205, pp. 4. [1 ref.]
Details are given of logging operations, residual stand, ground disturbance and slash conditions. Silvicultural implications are discussed.

32 FELLING AND RELATED OPERATIONS

Johnston, J. S., and St.-Laurent, A. 1971. CROSSCUT SHEARING OF FROZEN TREES. Pulp Paper Mag. Can. 72 (5), (97 . . . 108). [4 ref.]
Gives an illustrated account, with a table and graphs, of a study on the cutting of full-sized trees with a double-bladed shear assembly during cold weather in Canada when the wood temperature was as low as -15° F.

33 DEGREE OF UTILIZATION AND WASTE

Benson, M. K., and Einspahr, D. W. 1972. YIELDS FROM 18-YEAR-OLD ASPEN VIA TOTAL TREE HARVESTING. Genetics and Physiology Notes, Institute of Paper Chemistry No. 14, 8 pp. [E., 2 ref.]
Describes the results of harvesting (for use as chips for a pulpmill) all the above-ground parts of an 18-year-old Aspen stand (94% Populus tremuloides) in Wisconsin, and gives data from observations on sucker regeneration afterwards.

Napier, D. A. 1972. TOTAL TREE HARVESTING DOUBLES FIBER TONNAGE FROM ASPEN STAND. Journal of Forestry 70 (6) 343-344 [E.]

Young, H. E., Gammon, C. B., and Ashley, M. 1964. POTENTIAL FIBRE FROM BALSAM FIR, WHITE PINE, HEMLOCK, WHITE BIRCH, AND ASPEN LOGGING RESIDUES. Tappi 47 (9), (555-7). 3 refs.
Logging waste of all trees felled for industrial purposes in the U.S.A. must exceed the equivalent of 40 million cords per year, or roughly the present annual consumption by the entire U.S. pulp and paper industry.

36 TOOLS, MACHINES AND EQUIPMENT FOR FELLING AND RELATED OPERATIONS

Berlyn, R. W. 1965. THE EFFECT OF SOME VARIABLES ON THE PERFORMANCE OF A DRUM BARKER. Woodl. Res. Index Pulp Pap. Res. Inst. Can. No. 173, pp. 14. 5 refs. [E.e.f.]
Describes tests on logs of 9 hardwood and 5 softwood species using a commercial drum barker. Results showed that: bark removal apparently started at the ends of a log and progressed slowly towards the middle.

Berlyn, R. W. 1965. SOME VARIATIONS IN THE STRENGTH OF THE BOND BETWEEN BARK AND WOOD. Woodl. Res. Index Pulp Pap. Res. Inst. Can. No. 161, pp. 25. 3 refs. [E.e.f.]
Describes a study of such strength variations in both early summer and autumn, using the bark/wood bond-meter.

Erickson, J. R. 1967. CROSSCUT SHEARING OF WOOD. Proc. 14th Congr. Int. Union For. Res. Organ., Munich 1967 Pt. VIII, Sect. 32, (324-37). [9 refs. [E.e.].]
Reports on a laboratory study on the effect of knife thickness, bevel, keeness, and cutting speed on the cutting force required.

37 TRANSPORT

Sturos, J. A. 1973. THEORETICAL METHODS FOR ESTIMATING MOMENTS OF INERTIA OF TREES AND BOLES. USDA Forest Service Research Paper, North Central Forest Experiment Station No. NC-96, 10 pp. [E., 5 ref.]
Describes a preliminary study for designing logging machines.

4 FOREST INJURIES AND PROTECTION

41 GENERAL TECHNIQUE OF FOREST PROTECTION. TYPES OF

Maini, S. 1966. RECOVERY OF ASPEN SUCKERS FOLLOWING APICAL INJURY. Abstr. in Bull. Ecol. Soc. Amer. 47 (3), (114). [A.P.B.]
Describes the growth of P. tremuloides shoots after various intensities of natural and manual injury at different times of year.

416 TYPES OF INJURY

Maini, J. S. 1966. GROWTH OF POPULUS SPP. II. RELATIVE GROWTH POTENTIAL OF APICAL AND LATERAL BUDS. Canad. J. Bot. 44 (11), (1581-90).

416.4

Hubbes, M. 1964. HOST – PARASITE RELATIONSHIPS IN THE HYPOXYLON [PRUINATUM] CANKER OF ASPEN. Repr. from Breeding pest resistant trees. (Proceedings of a N.A.T.O. and N.S.F. Symposium, Pennsylvania State University. Pergamon Press, Oxford. 1966. pp. 229-38. [22 refs. Smry. 1 photo. 1 dgm. 4 tbls.]

Manion, P. D., and French, D. W. 1967. NECTRIA GALLIGENA

ND CERATOCYSTIS FIMBRIATA CANKERS OF ASPEN OPULUS TREMULOIDES] IN MINNESOTA. For. Sci. 13 (1), 3-8). [3 refs. Smry. 5 photos. 2 tbls.]

42 INJURIES FROM INORGANIC AGENCIES (EXCLUDING FIRE)

airs, G. R., and Jeffers, R. M. 1967. EFFECTS OF GAMMA ADIATION ON JUVENILE AND MATURE CUTTINGS OF UAKING ASPEN. For. Sci. 13 (3), (240-5). [13 refs.]
ooting response of mature cuttings of P. tremuloides was not creased by radiation treatments within the range 1-10 kr and ttings of juvenile wood showed a reduced growth rate and rooting ility.

rain, B. R. 1966. THE EFFECT OF A LATE SPRING FROST ON HE RADIAL GROWTH OF VARIANT QUAKING ASPEN BIO-PES. For. Sci. 12 (3), (334-7). [16 refs.]
mpares damage to foliage, and radial increment, of (a) early- and) late-leafing biotypes of P. tremuloides.

eshow, M. 1970. OZONE DAMAGE TO PLANTS. Environm. llut. 1 (2), (155-61). [12 ref. ORS]
general account, including a discussion of injury to conifers and a ief report of a fumigation experiment on the relative susceptibility various hardwoods.

all, R. E., Kalra, Y. P., and Prasad, R. 1971. CONCENTRATION F MICRONUTRIENTS IN FOLIAGE OF ASPEN (POPULUS REMULOIDES MICHX.) IN MANITOBA. Information Report, rest Research Laboratory, Edmonton, Canada No. A-X-47, 7 pp. ., 9 ref.]
il, and leaf-tissue samples of P. tremuloides from stands contain-g chlorotic trees and from symptomless adjacent stands, were llected. Foliar Fe, Mn and Zn differed significantly between them. il analyses revealed high contents of alkaline-earth carbonates in ils where chlorotic trees occurred.

43 FOREST FIRES

ouston, D. B. 1973. WILDFIRES IN NORTHERN YELLOW-TONE NATIONAL PARK. Ecology 54 (5) 1111-1117 [E., 31 f.]
stimates of the frequency of occurrence of fires, obtained from oss-sections taken from the butts of 40 fire-scarred trees.

431 PREDISPOSING FACTORS AND CAUSES. FIRE DANGER. FIRE BEHAVIOUR

hester, G. S., and Hopkins, E. J. 1964. AN UNUSUAL POTEN-IAL CAUSE OF FOREST FIRES. Fire Control Notes 25 (3), (12, 5).
escribes a fire in the duff layer, underneath a polythene eenhouse. Rainwater had collected on the roof and the resultant ol was acting as a burning lens.

hilpot, C. W. 1969. THE EFFECT OF REDUCED EXTRACTIVE ONTENT ON THE BURNING RATE OF ASPEN LEAVES. U.S. or. Serv. Res. Note Intermt. For. Range Exp. Sta. No. INT-92, pp. [9 refs.]
iethyl ether and acetone were used to reduce the extractive ontent of Aspen leaves. A direct relation was found between xtractive content and burning rate.

agner, C. E. van. 1965. STORY OF AN INTENSE CROWN FIRE T PETAWAWA. Pulp Paper Mag. Can. 66 (8), [WR 358-WR 361). E.e.f.]
escribes a severe fire in Ontario on 7 May 1964.

agner, C. E. van. 1967. SEASONAL VARIATION IN MOISTURE ONTENT OF EASTERN CANADIAN TREE FOLIAGE AND HE POSSIBLE EFFECT ON CROWN FIRES. Dep. Publ. For. Br. an. No. 1204, pp. 15 + 2. [12 refs. [E.e.f.].]
oliar moisture content was sampled in five eastern Canadian onifers and two hardwoods and seasonal trends were established. hese were basically similar from year to year despite weather ifferences.

agner, C. E. van. 1969. DRYING RATES OF SOME FINE OREST FUELS. Fire Control Notes 30 (4), (5, 7, 12). [2 refs.]
Removal of waxes and resins from the cuticles of Pine needles and Aspen leaves (by boiling in xylene) greatly increased their drying rate, which was slower than that of wood many times their thickness.

Wagner, C. E. van. 1970. AN INDEX TO ESTIMATE THE CURRENT MOISTURE CONTENT OF THE FOREST FLOOR. Publication, Canadian Forestry Service No. 1288, iv + 23 pp. [E.f., 13 ref.]
Describes the calculation of an index similar to, but not identical with, the US Buildup Index, increasing proportionally with the decrease in the logarithm of the moisture content.

Wagner, C. E. van. 1972. EQUILIBRIUM MOISTURE CONTENTS OF SOME FINE FOREST FUELS IN EASTERN CANADA. Information Report, Petawawa Forest Experiment Station No. PS-X-36, 7 pp. [E.] From Forest Fire Control Abstracts 23, 363.
Explains the importance of equilibrium moisture content (e.m.c.) in estimating the m.c. of both fast-drying and slow-drying fuels, and gives the results of a series of determinations of e.m.c. carried out on leaf litter.

Wagner, C. E. van. 1973. ROUGH PREDICTION OF FIRE SPREAD RATES BY FUEL TYPE. Information Report, Petawawa Forest Experiment Station, Canada No. PS-X-42, 9 pp. [E., 10 ref.]
Presents a generalized mathematical equation relating the rate of forward spread of fire to the two variables of ISI and ADMC and containing three parameters to define the behaviour of a given fuel type.

432 PREVENTION AND CONTROL

Grigel, J. E. 1971. AIR DROP TESTS WITH FIRE-TROL 100 and PHOS-CHEK 205 FIRE RETARDANTS. Information Report, Northern Forest Research Centre, Canada No. NOR-X-8, 41 pp. [E., 7 ref.]
Two retardants were dropped by an air-tanker on three sites: (1) an open field; (2) a Lodgepole Pine stand; (3) a White Spruce/Aspen stand. There was little difference between the distribution patterns of the two retardants on the same site, but the patterns differed between sites.

436 BENEFICIAL EFFECTS OF FIRE. USES OF FIRE IN SILVICULTURE AND OTHER FORMS OF HUSBANDRY

Buckman, R. E., and Blankenship, L. H. 1965. REPEATED SPRING PRESCRIBED BURNING REDUCES ABUNDANCE AND VIGOR OF ASPEN ROOT SUCKERING. J. For. 63 (1), (23-5).
The effect of burning on Populus tremuloides in north-central Minnesota, and its significance for forest and wild-life management, are discussed.

Kiil, A. D. 1970. EFFECTS OF SPRING BURNING ON VEGETATION IN OLD PARTIALLY CUT SPRUCE-ASPEN STANDS IN EAST-CENTRAL ALBERTA. Inform. Rep. For. Res. Lab., Edmonton No. A-X-33, 1970. pp. 12. [4 refs.]
Prescribed burning in 1969 in old, partially felled Picea glauca/Populus tremuloides stands.

Methven, I. R., and Murray, W. G. 1974. USING FIRE TO ELIMINATE UNDERSTORY BALSAM FIR IN PINE MANAGEMENT. Forestry Chronicle 50 (2) 77-79 [E.f., 9 ref.]
Describes three small-scale trials in Ontario on the effects of low-intensity controlled burning in a 90-year-old stand of Pinus resinosa and P. strobus with a dense understory of Abies balsamea.

Perala, D. A. 1974. PRESCRIBED BURNING IN AN ASPEN-MIXED HARDWOOD FOREST. Canadian Journal of Forest Research 4 (2) 222-228 [E., 28 ref.]
The effects of (a) prescribed burning and (b) complete clear felling on P. tremuloides and associated hardwoods and shrubs were compared for 8 years after commercial logging of a 60-year-old P. tremuloides stand in Minnesota.

Perala, D. A. 1974. REPEATED PRESCRIBED BURNING IN ASPEN. USDA Forest Service Research Note, North Central Forest Experiment Station No. NC-171, 4 pp. [E., 5 ref.]
Describes the effects of felling a stand of P. tremuloides and prescribed burning of the area in the spring 2 and 4 years after felling, and in the autumn 5 years after felling in order to clear the area for conifers.

Tucker, R. E., and Jarvis, J. M. 1967. PRESCRIBED BURNING IN A WHITE SPRUCE – TREMBLING ASPEN STAND IN MANITOBA. Pulp Paper Mag. Can. 68 (7), (WR 333-WR 335). [8 refs.]
Briefly reports successful slash-burning trials in felled Picea glauca/Populus tremuloides stands, and tabulates data on air temperature, wind speed, moisture content of slash and litter, etc.

44 DAMAGE BY HARMFUL PLANTS. VIRUS DISEASES

441 FOREST WEEDS

Sharma, M. P., and Vanden Born, W. H. 1970. FOLIAR PENETRATION OF PICLORAM AND 2,4-D IN ASPEN AND BALSAM POPLAR. Weed Science, Urbana 18 (1), (57-63). [26 ref. From abstr. in Weed Abstr. 1971 20 (2), (No. 852). OW]

Zimmerman, C. C. 1964. FENURON, A PROMISING NEW TOOL FOR FOREST RENOVATION IN THE NORTHEAST. Proc. 16th Ntheast. Weed Control Conf. 1962 (417-25). From abstr. in Weed Abstr. 13 (2), (435). O.W.
In a 3-year trial in a hardwood/conifer forest, basal applications of fenuron pellets at rates between 0·25 and 1 oz./tree gave up to 80% kill of undesirable hardwood species.

442 PARASITIC (HIGHER) PLANTS. CLIMBERS AND EPIPHYTES

Jonescu, M. E. 1970. LICHENS ON POPULUS TREMULOIDES IN WEST-CENTRAL CANADA. Bryologist 73 (3): 557-578. [map.]

443 FUNGI AND BACTERIA

Bacon, M., and Mead, C. E. 1971. BACTERIA IN THE WOOD OF LIVING ASPEN, PINE, AND ALDER. Northw. Sci. 45 (4), (270-5). [15 ref.]
Isolations were made in the laboratory of micro-organisms from wood samples of healthy Populus tremuloides, Pinus ponderosa and Alnus tenuifolia, collected in Spokane County, Wash. The manner of their entry into the living tree is discussed.

Boyer, M. G., and Navratil, S. 1970. SOME ASPECTS OF TRANSMISSION AND ELECTRON MICROSCOPY OF NECROTIC LEAF SPOT OF ASPEN. Can. J. Bot. 48 (6): 1141-1145.

Garner, J. H. B., and French, D. W. 1965. A PRELIMINARY SURVEY OF THE FUNGI ON AND IN HEALTHY BARK OF TREMBLING ASPEN (POPULUS TREMULOIDES). Abstr. in Phytopathology 55 (10), (1059).
Lists genera isolated from 9 trees in 3 Minnesota stands aged 8, 40, and 45 years.

Hulme, M. A., and Stranks, D. W. 1974. INFLUENCE OF CARBOHYDRATE ACCESSIBILITY ON CELLULASE PRODUCTION BY LENZITES TRABEA AND POLYPORUS VERSIOCOLOR. Aust. J. Biol. Sci. 27 (4): 457-464. [Ref.]

Millikan, D. F. 1974. HYPOXYLON CANKER OF ASPEN. 'Hypoxylon pruinatum,' Populus tremuloides. Am. Nurserym 140 (11): 60-61.

443.3

Anderson, D. L., and French, D. W. 1972. GERMINATION OF ASCOSPORES OF HYPOXYLON MAMMATUM IN LIVING ASPEN. Canadian Journal of Botany 50 (9) 1973-1974 [E.f., 5 ref. ORS]
Ascospores of H. mammatum, injected in suspension through artificial wounds into the stems of naturally occurring P. tremuloides trees, germinated in the sapwood. The observed germination never exceeded 7%.

Anderson, D. L., and French, D. W. 1972. ISOLATION OF HYPOXYLON MAMMATUM FROM ASPEN STEM SECTIONS. Canadian Journal of Botany 50 (9) 1971-1972 [E.f., ORS]
A means of natural infection of P. tremuloides by H. mammatum has not yet been demonstrated, although it has been assumed that ascospores are responsible.

Anderson, G. W. 1971. AERIALLY APPLIED ANTIBIOTICS FAIL TO CONTROL HYPOXYLON CANKER ON ASPEN. Plant Dis. Reptr. 55 (7), (650).
Tabulates data for the years 1963-1970 on mortality and callu formation associated with Hypoxylon mammatum cankers on P tremuloides trees in Minnesota after treatment with five differen antibiotic formulations applied from the air.

Anderson, G. W. 1972. DEVELOPMENT OF HYPOXYLON MAM MATUM CANKERS ON ARTIFICIALLY SHADED ASPEN STEMS. Forest Science 18 (4) 316-318 [E., 2 ref.]

Anderson, G. W., and Anderson, R. L. 1968. RELATIONSHI BETWEEN DENSITY OF QUAKING ASPEN AND INCIDENCI OF HYPOXYLON CANKER. For Sci. 14 (1), (107-12). [4 refs.]
Thinning a 10-year-old stand of P. tremuloides did not reduce th subsequent prevalence of Hypoxylon pruinatum canker.

Anderson, R. L., and Anderson, G. W. 1969. HYPOXYLON CANKER OF ASPEN. For. Pest. Leafl. U.S. For. Serv. No. 6 (rev. pp. 6. [4 refs.]
H. pruinatum is the most important killing disease of P. tremuloides In the Lake States it is reckoned that it reduces net annual growt by one-third.

Bagga, D. K. 1968. PHYSIOLOGY OF HYPOXYLON PRUINATUM AND ITS PATHOGENESIS ON QUAKING ASPEN. Abstr. o thesis, in Dissert. Abstr. 29B (6), (1897). [University of Wisconsin. (Order No. 68-13,615. Price: Microfilm $3.00; Xerography $8.00 pp. 173.)

Bagga, D. K., and Smalley, E. B. 1967. WATER STRESS IN RELATION TO INITIATION AND DEVELOPMENT OF HYPOXYLON CANKER OF ASPEN. Abstr. in Phytopatholog 57 (8), (802).
When 3-month-old rooted cuttings inoculated with H. pruinatum were grown in the greenhouse under various watering regimes, th incidence and size of the cankers increased with water stress.

Bagga, D. K., and Smalley, E. B. 1969. FACTORS AFFECTING CANKER DEVELOPMENT ON POPULUS TREMULOIDES INOCULATED WITH HYPOXYLON PRUINATUM. Canad. J. Bot 47 (6), (907-14 + 1 photo). [25 refs. O.R.S.]
A full account of the greenhouse study.

Bagga, D. K., and Smalley, E. B. 1974. THE DEVELOPMENT OF HYPOXYLON CANKER OF POPULUS TREMULOIDES ROLE OF ASCOSPORES, CONIDIA, AND TOXINS. Phytopatholog 64 (5) 654-658 [E., 12 ref.]
Reports a series of experiments to clarify the role of ascospores an conidia of Hypoxylon pruinatum in the natural spread of disease. I is suggested that conidia may be involved in natural pathogenesis and that very large clumps of ascospores, such as might be carrie by insects, could contain high enough concentrations of th phytotoxic metabolite to cause canker development.

Bagga, D. K., and Smalley, E. B. 1974. THE DEVELOPMENT OF HYPOXYLON CANKER OF POPULUS TREMULOIDES: ROLE OF INTERACTING ENVIRONMENTAL FACTORS. Phyto pathology 64 (5) 658-662 [E., 19 ref.]
Reports growth-chamber studies of the influence of air temperature relative humidity (r.h.), available soil moisture, soil type, and th moisture present at the inoculum site, on the development o disease caused by H. pruinatum.

Bagga, D. K., and Smalley, E. B. 1974. VARIATION OF HYPOXYLON PRUINATUM IN CULTURAL MORPHOLOGY AND VIRULENCE. Phytopathology 64 (5) 663-667 [E., 13 ref.]
Single-ascospore isolates of the fungus showed extreme variability i cultural morphology, conidial production, and virulence to P tremuloides. Virulence (measured by the length of canker produced was not related to the rate of growth in culture.

Bagga, D. K., Smalley, E. B., and Berbee, J. G. 1974. CONIDIAL STAGE OF HYPOXYLON PRUINATUM: FACTORS INFLUENCING PILLAR PRODUCTION AND CONIDIAL GERMINATION. Phytopathology 64 (3) 411-413 [E., 13 ref.]
Reports studies: (a) of the germination of conidia in vivo, on an aga medium; and (b) of the development of conidial pillars (stromata) i vitro, on naturally infected pieces of stem of P. tremuloides.

Baranyay, J. A. 1967. NOTES ON HYPOXYLON CANKER OF ASPEN IN ALBERTA. For. Chron. 43 (4), (372-80). [10 refs [E.e.f.].]

he rate of canker growth caused by Hypoxylon pruinatum on P. emuloides and the intensification of the disease were investigated n a sample plot established in 1963 in a heavily infected stand in lk Island National Park.

aranyay, J. A., and Hiratsuka, Y. 1967. IDENTIFICATION AND ISTRIBUTION OF CIBORINIA WHETZELII (SEAVER) EAVER IN WESTERN CANADA. Canad. J. Bot. 45 (2), (189-91 + 2 photos). [3 refs. [E.f.] 1 sketch map.]

asham, J. T., and Morawski, Z. J. R. 1964. CULL STUDIES. THE EFECTS AND ASSOCIATED BASIDIOMYCETE FUNGI IN THE EARTWOOD OF LIVING TREES IN THE FORESTS OF NTARIO. Publ. Dep. For. Can. No. 1072, pp. 67. 16 refs. [E.e.f.]

er, J. E. 1965. SOME INOCULUM FACTORS IN PATHO-ENICITY STUDIES OF HYPOXYLON PRUINATUM KLOTZSCHE) CKE. ON POPULUS TREMULOIDES MICHX. epr. from Canad. J. Bot. 43 (8), (877-83 + 12 photos). 7 refs. *fection rates were higher with bark-meal or mycelial inocula than ith agar plugs both in wounds exposing the xylem and in mere rk wounds.*

er, J. E. 1966. SOME PROBLEMS OF INOCULUM POTENTIAL N CULTURAL AND PATHOGENICITY TESTS RELATED TO ISEASE RESISTANCE. Repr. from Breeding pest-resistant trees. rgamon Press, Oxford. pp. 441-8. [5 refs.] *ifferent results were obtained in pathogenicity tests on P. emuloides with Hypoxylon pruinatum inoculum raised on differ-nt substrates.*

own, T. S., Jr., and Merrill, W. 1971. GERMINATION OF OMES IGNIARIUS VAR. POPULINUS BASIDIOSPORES ON SPEN PITH. Abstr. in Phytopathology 61 (8), (886-7). *udies on the germination of spores and the penetration of branch ubs of P. tremuloides by F.i. var. populinus indicated that the pith ay serve as a point of entry for the fungus.*

hen, Z. C. [Chen, S. C.] 1972. ELECTRONMICROSCOPIC EVI-ENCES OF INFECTION OF THE HEART-ROT FUNGUS, OMES IGNIARIUS VAR. POPULINUS ON LIVING ASPEN REES. Technical Bulletin, Experimental Forest of National aiwan University No. 105, 15 pp. [E.chin., 19 ref.] *opulus tremuloides trees 10-15 cm in diameter in New York were oculated with a basidiospore suspension of F. igniarius in ore-holes 2 cm deep in June 1969. F. igniarius was recovered in olation from fast-growing imperfect fungi by culturing small chip mples.*

opony, J. A., and Barnes, B. V. 1974. CLONAL VARIATION IN HE INCIDENCE OF HYPOXYLON CANKER ON TREMBLING SPEN. Canadian Journal of Botany 52 (7) 1475-1481 [E.f., ORS] *he incidence of canker caused by H. mammatum on ramets of 80 ole-sized clones of P. tremuloides was determined at five sites in ichigan. Variation in the incidence of canker within clones was ight, but significant differences were found between clones at four f the five sites.*

ance, B. W. 1968. OBSERVATIONS ON THE DEVELOPMENT F HYPOXYLON CANKERS ON TREMBLING ASPEN. Plant Dis. eptr. 52 (8), (659-61). [4 refs.] *tems of young P. tremuloides in Ontario inoculated with mycelium f H. pruinatum in Aug. 1959 had dead bark above and below all noculation sites in Aug. 1961.*

ance, B. W., Lynn, D. F. and Jansons, V. 1964. OBSERVATIONS N THE EFFECTS OF STEM CANKERS ASSOCIATED WITH EZICULA OCELLATA (PERS.) SEAVER IN YOUNG TREM-LING ASPEN. Bi-m. Progr. Rep. For. Ent. Path. Br. Dep. For. an. 20 (3), (2-3). *hile young Aspen trees (P. tremuloides) can quickly recover from ie external symptoms of this disease, permanent internal injury in ie form of brown heartwood stain results from the condition.*

rench, D. W., Hodges, C. S., Jr., and Froyd, J. D. 1969. PATHO-ENICITY AND TAXONOMY OF HYPOXYLON MAMMATUM. anad. J. Bot. 47 (2), (223-6 + 11 figs.). [3 refs. O.R.S.] *n morphological grounds, H. pruinatum is considered to be dentical with H. mammatum, a saprophyte on Alder and other pecies, but may be a special pathogenic form.*

rench, J. R., and Manion, P. D. 1973. EFFECTS OF HOST TISSUE ON GERMINATION AND GROWTH OF HYPOXYLON MAMMATUM. [Abstract]. Phytopathology 63 (2): 201. [E.] *Observations indicate that primary infection of P. tremuloides by H. mammatum commonly occurs near the growing tips of young stems.*

Froyd, J. D., and French, D. W. 1967. EJECTION AND DIS-SEMINATION OF ASCOSPORES OF HYPOXYLON PRUINA-TUM. Canad. J. Bot. 45 (9), (1507-17). [11 refs. O.R.S.] *In perithecial stromata artifically wetted once in 24 hr., the duration of ejection was related to moisture condition. When stromata were kept moist, peak ejections occurred every 12 hr. Cankers on felled Aspen stems produced fewer stromata, but these released more spores, than those on standing controls.*

Garner, J. H. B. 1967. SOME NOTES ON THE STUDY OF BARK FUNGI. Canad. J. Bot. 45 (4), (540-1). [8 refs., O.R.S.] *In a study of bark from 21 healthy trees of P. tremuloides from 7 stands in Minnesota, 34 genera of Fungi imperfecti, 5 of Aseo-mycetes, and one genus (Mucor) of Zygomycetes were isolated, but no Basidiomycetes.*

Gilbertson, R. L., and Budington, A. B. 1970. THREE NEW SPECIES OF WOOD-ROTTING FUNGI IN THE CORTICIACEAE. Mycologia 62 (4), (673-8). [5 refs., O.R.S.] *Describes Trechispora pallidoaurantiaca, from Pines, Picca mariana and tremuloides from various parts of N. America.*

Hawksworth, D. L. 1972. HYPOXYLON MEDITERRANEUM. CMI Descriptions of Pathogenic Fungi and Bacteria No. 359, 2 pp. [E.] *Describes H. mediterraneum, an important pathogen of Quercus suber. It is also found on other Quercus spp., Castanea spp., Eucalyptus spp., Fagus sylvatica, Platanus hybrids[?], P. orientalis, Populus tremuloides and Shorea robusta.*

Hinds, T. E. 1972 [I] CERATOCYSTIS CANKER OF ASPEN. [II] INSECT TRANSMISSION OF CERATOCYSTIS SPECIES ASSO-CIATED WITH ASPEN CANKERS. Phytopathology 62 (2): 213-20, 221-5. [18 + 14 ref.] *(I) Describes this disease of P. tremuloides and its distribution in the western USA. Stem inoculations in Colorado confirmed that C. fimbriata was a causal agent and that C. tremulo-aurea was not. (II) Insects of eleven families were collected from fresh bark injuries in Colorado in summer. Nearly all were vectors of C. fimbriata and other species.*

Hinds, T. E., and Anderson, G. W. 1970. SOME CERATOCYSTIS SPP. AND A CENANGIUM FOUND ON MINNESOTA ASPEN. Plant Dis. Reptr. 54 (6): 460-1. [10 refs.] *Records the first reported occurrence in Minnesota, on P. tremu-loides, of Ceratocystis crassivaginata, C. populina, C. tremulo-aurea and C. alba, and of Cenangium singulare.*

Hinds, T. E., and Peterson, R. S. 1966. ANTIBIOTIC TESTS ON WESTERN GALL RUST AND ASPEN CANKERS. Plant Dis. Reptr. 50 (10): 741-4. [7 refs., I. M. I.] *Fruiting of cankers caused by Peridermium harknessii on Lodgepole and Ponderosa Pines was temporarily reduced by cycloheximide and phytoactinbole sprays at 200 p.p.m., but fruiting above the treated area was not affected.*

Hubbes, M. 1969. BENZOIC AND SALICYLIC ACIDS ISOLATED FROM A GLYCOSIDE OF ASPEN BARK AND THEIR EFFECT ON HYPOXYLON PRUINATUM. Canad. J. Bot. 47 (8): 1295-1301. [18 refs. [E.e.f.] O.R.S.] *Benzoic and salicylic acid isolated from an unknown glycoside were found to be the main fungistatic factors against H. pruinatum. Benzoic acid was more inhibitory than salicylic acid.*

Hubbes, M. 1964. THE INVASION SITE OF HYPOXYLON PRUINATUM IN POPULUS TREMULOIDES. Abstr. in Phyto-pathology 54 (8): 896. *Pyrocatechol and other chemicals present in Aspen bark were inhibitory to H. pruinatum. The fungus on agar plugs was killed when placed on the bark of fresh wood disks but grew well on sapwood.*

Hubbes, M., and Astous, R. D. 1967. FACTORS AFFECTING THE GERMINATION OF SPORES OF HYPOXYLON PRUINATUM. Canad. J. Bot. 45 (7): 1145-53. [16 refs., O.R.S.] *Germination of conidia and ascorpores was inhibited on healthy or wounded (most strongly on freshly wounded) Aspen bark.*

Hubbes, M., and Etheridge, D. E. 1965. A CHEMICAL BASIS FOR SELECTION OF HEARTWOOD FUNGI IN BALSAM FIR. Repr. from Canad. J. Bot. 43 (1): 181-3. 3 refs.

Iverson, C. G. 1968. EPIDEMIOLOGY OF WHITE TRUNK ROT OF ASPEN INCITED BY FOMES IGNIARIUS VAR. POPULINUS (NEUMAN) CAMPBELL. Abstr. of thesis, in Dissert, Abstr. 28B (11); 4377. [O.R.S.]
Viable spores were released by sporophores throughout the year, except during periods of prolonged drought or below-zero temperatures. Poison girdling of infected trees prevented spore release in all attached sporophores within a year. The effects of temperature and humidity on spore germination in culture are discussed.

Knutson, D. M. 1973. THE BACTERIA IN SAPWOOD, WETWOOD, AND HEARTWOOD OF TREMBLING ASPEN (POPULUS TREMULOIDES). Canadian Journal of Botany 51 (2): 498-500. [E.f., 13 ref., ORS]
Bacteria (Erwinia, Bacillus) were consistently isolated from all samples of P. tremuloides sapwood and heartwood studied. In zones of wetwood or discoloured heartwood the populations were often large.

Laflamme, G., and Lortie, M. 1972. [RELATIONS BETWEEN WOOD DECAY AND EXTERNAL DEFECTS IN DIFFERENT CLONES OF POPULUS TREMULOIDES.] Naturaliste Canadien 99 (5): 449-456. [F.e., 22 ref., NLL]
Presents the results of studies of the number and type of visible defects in P. tremuloides naturally regenerated from root suckering.

Laflamme, G., and Lortie, M. 1973. [MICROORGANISMS IN DISCOLOURED AND DECAYED WOOD OF POPULUS TREMULOIDES.] Canadian Journal of Forest Research 3 (2): 155-160. [F.e., 19 ref.]
Three main genera of Fungi Imperfecti (Phialophora, Libertella and Ascocoryne) were isolated from samples of healthy, discoloured and decayed wood from trees in two 45-year-old stands in Quebec. The commonest decay organism was Corticum polygonium.

Landis, T. D., and Evans, A. K. 1974. A RELATIONSHIP BETWEEN FOMES APPLANATUS AND ASPEN WINDTHROW. Plant Disease Reporter 58 (2): 110-113. [E., 5 ref.]
Reports an investigation in a stand of 100 to 120-year-old trees of P. tremuloides in SW Colorado.

Lortie, M. 1969. INOCULATIONS OF NECTRIA GALLIGENA ON NORTHERN HARDWOODS. Contr. Fonds Rech. For. Univ. Laval No. 13, pp. 31. [32 refs. [E.f.].]
Experimental inoculations indicated that Betula alleghaniensis was more susceptible than Acer saccharum. Fagus grandifolia and Populus tremuloides proved very resistant to infection, lesions healing over very quickly.

Maini, J. S., and Dance, B. W. 1965. TEMPERATURE RELATIONSHIPS OF A BLIGHT ATTRIBUTED TO FUSARIUM SOLANI (MART.) SACC. ON TREMBLING ASPEN SUCKERS. Bi-m. Progr. Rep. For. Ent. Path. Br. Dep. For. Can. 21 (2): 2-3.
During experimental studies on the suckering response of P. tremuloides to different temperature regimes and in darkness, it was observed that necrotic lesions developed on the leaves and stems of young suckers. Under the conditions of the present study, the fungus appears to act as a parasite whose pathogenicity is closely related to temperature.

Manion, P. D. 1968. FACTORS AFFECTING THE GERMINATION OF BASIDIOSPORES OF THE HEART ROT FUNGUS, FOMES IGNIARIUS [VAR. POPULINUS] IN THE INFECTION OF TREMBLING ASPEN. Abstr. of thesis, in Dissert. Abstr. 28B (12, Part I), (4836-7). O.R.S.]
Factors considered in field studies were the age of the wound (fresh to 8 days old) and the date of inoculation (April to August).

Manion, P. D., and French, D. W. 1968. INOCULATION OF LIVING ASPEN TREES WITH BASIDIOSPORES OF FOMES IGNIARIUS VAR. POPULINUS. Phytopathology 58 (9): 1302-4. [7 refs.]
Basidospores of F. i. var. populinus in sapwood wounds of P. tremuloides germinated well in fresh wounds and 2-day-old wounds very slightly in 4-day-old wounds, and not at all in 6-day or older wounds.

Manion, P. D., and Valentine, F. A. 1971. DISEASES OF TREMBLING ASPEN IN THE ADIRONDACK REGION OF NEW YORK Plant Dis. Reptr. 55 (8): 662-5. [11 ref.]
Survey of P. tremuloides showed that 9% were infected wit Hypoxylon mammatum canker, 10% with Fomes igniarius heart r and 6% with Nectria galligena canker.

Marks, G. C., Berbee, J. G., and Riker, A. J. 1965. DIREC PENETRATION OF LEAVES OF POPULUS TREMULOIDES B COLLETOTRICHUM GLOEOSPORIOIDES. Phytopatholog 55 (4): 408-12. [16 refs., Smry.]
Studies of young susceptible leaves, and old resistant leaves, sugge that growth forces, rather than osmotic pressure are primaril responsible for infection and penetration.

Nord, J. C., and Knight, F. B. 1972. THE IMPORTANCE O SAPERDA INORNATA AND OBEREA SCHAUM (COLEOPTERA: CERAMBYCIDAE) GALLERIES AS INFE TION COURTS OF HYPOXYLON PRUINATUM IN TREMBLIN ASPEN, POPULUS TREMULOIDES. Great Lakes Entomologi 5 (3): 87-92. [E.Cf., FA 33, 6613] From review of Plant Patholog 53, 4141.

Rice, P. F. 1970. SOME BIOLOGICAL EFFECTS OF VOLATILE EMANATING FROM WOOD. Canad. J. Bot. 48 (4): 719-35 + photos). [30 refs., O.R.S.]
A study of growth retardations in Phaseolus vulgaris and growt promotion in Fomes annosus emanating from heat-dried Pinu resinosa wood. Populus tremuloides produced volatiles.

Riffle, J. W., and Hinds, T. E. 1969. HYPOXYLON CANKER O ASPEN IN NEW MEXICO AND ARIZONA. Plant Dis. Reptr. 196 53 (6): 454. [5 refs., 1 fig.]

Rogers, J. D., and Berbee, J. G. 1964. DEVELOPMENTA MORPHOLOGY OF HYPOXYLON PRUINATUM IN BARK O QUAKING ASPEN. Phytopathology 54 (2): 154-62. 24 refs.
A description of hyphae destroying all bark cells except periden and sclerenchyma, the conidial stage and the perfect stage.

Schipper, A. L. Jr. 1970. SUGAR ACCUMULATION ASS CIATED WITH HYPOXYLON MAMMATUM CANKER DEVELO MENT IN ASPEN. Abstr. in Phytopathology 60 (9): 1312.
Saplings of P. tremuloides with H. mammatum cankers wer sampled for free-sugar content. Gas chromatography indicated th the sugars were derived from the phloem transfocation stream.

Schipper, A. L., Jr. 1972. CHANGES IN GLUCOSE-6 PHOSPHAT DEHYDROGENASE, GLYCERALDEHYDE-3 PHOSPHAT DEHYDROGENASE, AND PEROXIDASE ACTIVITY I POPULUS TREMULOIDES AFTER INOCULATION WITH HY POXYLON MAMMATUM OR WOUNDING.[Abstract]. Phyt pathology 62 (7): 787-788. [E.]

Schipper, A. L., Jr., and Anderson, G. W. 1971. ALTERATION O SUGAR TRANSLOCATION IN ASPEN BY HYPOXYLON MAM MATUM. Phytopathology 61 (4): 366-8. [8 refs.]

Smerlis, E. 1968. HOSTS AND PATHOGENICITY OF GODRONI FULIGINOSA. Plant Dis. Reptr. 52 (2): 167-8. [1 ref.]
Strains of G. fuliginosa were isolated from P. tremuloides, a ne host.

Smerlis, E. 1969. PATHOGENICITY OF SOME SPECIES O GODRONIA OCCURRING IN QUEBEC. Plant Dis. Reptr. 53 (10) 807-10. [3 refs.]
In inoculation tests, G. cassandrae f. betulicola was pathogenic on P tremuloides.

Smith, C. G. 1971. OVERWINTERING OF CLEISTOCARPS O UNCINULA SALICIS AND MICROSPHAERA PENICILLATA I ALBERTA. Trans. Brit. Mycol. Soc. 56 (2): 275-9. [9 ref., OBD]

Steneker, G. A., and Wall, R. E. 1972. WOUND HEALING AN FUNGAL COLONIZATION IN STEMS OF YOUNG TREMBLIN ASPEN AFTER THINNING AND PRUNING. Information Repor Northern Forest Research Centr, Canada No. NOR-X-37, 25 pp. [E. 17 ref.]
The season of pruning and the dressing of wounds had litt influence on wound healing and fungal colonization.

Takai, S., and Hubbes, M. 1973. POLYPHENOL-OXIDAS ACTIVITY AND GROWTH INHIBITION OF HYPOXYLO

PRUINATUM (KLOTZSCHE) CKE. BY ASPEN BARK MEAL. Phytopathologische Zeitschrift 78 (2): 97-108. [E.de., 20 ref.]
Describes a laboratory study with bark meal of P. tremuloides. Fungal growth was fastest with bark meal from the two top sections and slowest with meal from the base of the stem.

Treshow, M., and Harward, M. 1965. PRELIMINARY INVESTIGATIONS IN THE INCIDENCE OF CANKER AND DECLINE IN UTAH ASPEN STANDS. Proc. Utah Acad. Sci. 42 (2): 196-200.

Wall, R. E. 1971. VARIATION IN DECAY IN ASPEN STANDS AS AFFECTED BY THEIR CLONAL GROWTH PATTERN. Canad. J. For. Res. 1 (3): 141-6. [E.f., 14 ref.]
Describes a study of two mature even-aged stands of P. tremuloides in Manitoba. Results show highly significant differences among clones in % decay, volume of decay, gross volume, and net volume.

Wall, R. E., and Kuntz, J. E. 1964. INOCULATION OF HARDWOODS WITH FOMES IGNIARIUS. For. Res. Note Wis. Coll. Agric. No. 109, pp. 4. 11 refs.
Standing trees were inoculated. Decay, attributed to F. igniarius, was induced in 25-57% of the inoculated trees.

Wall, R. E., and Kuntz, J. E. 1964. WATER-SOLUBLE SUBSTANCES IN DEAD BRANCHES OF ASEPN (POPULUS TREMULOIDES MICHX.) AND THEIR EFFECTS ON FOMES IGNIARIUS. Canad. J. Bot. 42 (8): 969-77 + 3 photos. 12 refs. O.R.S.
The selective stimulating or inhibiting effect of bark extracts was not found until 10 years after death, and not in branches dead > 15 years.

Wang, S. S., and Anderson, N. A. 1967. THE MATING TYPE FACTORS OF PLEUROTUS OSTREATUS IN A LIMITED GEOGRAPHIC AREA. Abstr. in Phytopathology 57 (8), 835.

Winch, J. E., and Manion, P. [D.] 1971. RELATIONSHIP OF BASIDIOSPORE GERMINATION OF FOMES IGNIARIUS TO HOST SPECIFICITY. Abstr. in Phytopathology 61 (8), 917.

Wood, F. A. 1964. CERATOCYSTIS CANKER OF ASPEN IN PENNSYLVANIA. Plant Dis. Reptr. 48 (6), 441. 1 ref. I.M.I.
The first report of C. fimbriata from the eastern U.S.A.

Wood, F. A., and French, D. W. 1965. HYPOXYLON CANKER OF ASPEN: SEASONAL DEVELOPMENT OF CANKERS AND ASCOSPORE EJECTION IN WINTER. Phytopathology 55 (7), 771-4. 8 refs.

Wood, F. A., and French, D. W. 1965. MICROORGANISMS ASSOCIATED WITH HYPOXYLON PRUINATUM. Mycologia 57 (5), 766-75. 7 refs. O.R.S.
In 72% of H. pruinatum Aspen cankers studied in Minnesota, perithecia were contaminated with bacteria.

Zalasky, H. 1965. MORPHOLOGY OF CERATOCYSTIS FIMBRIATA IN ASPEN. Repr. from Canad. J. Bot. 43 (6), 625-6 + 11 photos. 5 refs.
Describes observations on morphology, distribution of mycelia in young suckers and older stems, production of perithecia and endoconidia in and on host tissues, etc.

Zalasky, H. 1968. PENETRATION AND INITIAL ESTABLISHMENT OF NECTRIA GALLIGENA IN ASPEN AND PEACHLEAF WILLOW. Canad. J. Bot. 46 (1), 57-60. [10 refs., O.R.S.]
Histological studies of artificially inoculated P. tremuloides and Salix amygdaloides showed that Nectria galligena penetrated the periderm directly.

Zalasky, H. 1965. PROCESS OF CERATOCYSTIS FIMBRIATA INFECTION IN ASPEN. Repr. from Canad. J. Bot. 43 (10), 1157-62 + 17 photos. 6 refs.
Describes inoculation tests on greenhouse-grown root suckers and 5-year trees from a natural stand.

45 DAMAGE BY ANIMALS

451 MAMMALS

Krebill, R. G. 1972. MORTALITY OF ASPEN ON THE GROS VENTRE ELK WINTER RANGE. USDA Forest Service Research Paper, Intermountain Forest and Range Experiment Station No. INT-129, 16 pp. [E., 16 ref.]
Stands of P. tremuloides were sampled and the mortality rate was estimated to be ca. 3.6% per year. Mortality was due to a variety of causes following bark wounding of stems by elk [Cervus canadensis nelsoni] and possibly moose.

451.2

Dietz, D. R., and Tigner, J. R. 1968. EVALUATION OF TWO MAMMAL REPELLENTS APPLIED TO BROWSE SPECIES IN THE BLACK HILLS. J. Wildlife Mgmt. 32 (1), 109-14. [8 refs., Smry., 3 tbls.]

Northcott, T. H. 1971. FEEDING HABITS OF BEAVER IN NEWFOUNDLAND. Oikos 22 (3), 407-10. [10 ref.]
Describes a study to investigate the utilization of vegetation by beavers in the relative absence of their preferred species.

452 BIRDS

Erskine, A. J., and McLaren, W. D. 1972. SAPSUCKER NEST HOLES AND THEIR USE BY OTHER SPECIES. Canadian Field-Naturalist 86 (4), 357-361. [E., 20 ref., NLL]
Presents the results of investigations in the Cariboo Parklands of British Columbia together with data from Canadian nest record cards on tree species used for nesting by Sphyrapicus varius, and on the dimensions and situation of the nests. The sapsuckers most commonly nest in Populus tremuloides in the early stoges of heart rot; in the southern part of their range, where Aspen is less common, they use a wide variety of broadleaved trees. Some data are given on predators and competitors for nesting sites.

453 INSECTS

Beckwith, R. C. 1968. THE LARGE ASPEN TORTRIX, CHORISTONEURA CONFLICTANA (WLKR.), IN INTERIOR ALASKA. U.S. For. Serv. Res. Note Pacif. Nthwest. For. Range Exp. Sta. No. PNW-81, pp. 10. [4 refs.]
Discusses material, methods, and results of the life history of the insects, which caused defoliation over an area of 5000 sq. miles in Aspen types.

Beckwith, R. C. 1970. INFLUENCE OF HOST ON LARVAL SURVIVAL AND ADULT FECUNDITY OF CHORISTONEURA CONFLICTANA (LEPIDOPTERA: TORTRICIDAE). Canad. Ent. 102 (11), 1474-80. [10 refs., O.R.S.]
A diet of P. tremuloides is essential to give impetus to population increases of C. conflictana.

Beckwith, R. C. 1973. THE LARGE ASPEN TORTRIX [CHORISTONEURA CONFLICTANA]. Forest Pest Leaflet, Forest Service, US Department of Agriculture No. 139, 5 pp. [E., 4 ref.]
Gives an account of C. conflictana, a pest of P. tremuloides, including its life history and natural control factors.

Benoit, P. 1965. [LARVAL MORPHOLOGY OF AGRILUS LIRAGUS AND A. ANXIUS.] Repr. from Canad. Ent. 97 (7), 768-73. 5 refs. [F.e.]
Describes in detail A. liragus and gives distinctive characters of A. anxius.

Benoit, P. 1965. NOTE ON DICERCA CALLOSA CASEY (COLEOPTERA: BUPRESTIDAE) IN CANADA. Bi-m. Progr. Rep. For. Ent. Path. Br. Dep. For. Can. 21 (2), 2.
Notes on the identity and taxonomy of a number of ♂ specimens collected from P. tremuloides.

Boss, G. D. 1972. INSECTS AFFECTING QUAKING ASPEN IN COLORADO. [Abstract.] Dissertation Abstracts International. B 33 (6), 2426. [E., ORS, Order No. 72-31, 312]
Species causing most damage of P. tremuloides were Malacosoma californicum, Saperda calcarata, S. moesta and Pecilonota cyanipes, and three species of leaf-hoppers in the genus Idiocerus.

Churchill, G. B., et al. 1964. LONG RANGE EFFECT ON ASPEN OF DEFOLIATION BY THE FOREST TENT CATERPILLAR. Minn. For. Note No. 147, pp. 2. 1 ref.

Churchill, G. B., et al 1964. LONG-TERM EFFECTS OF DEFOLIATION OF ASPEN BY THE FOREST TENT CATERPILLAR. Ecology 45 (3), 630-3. 5 refs.

Clarke, L. J., and Pardy, K. E. 1970. BIOLOGICAL CONTROL OF THE SATIN MOTH IN NEWFOUNDLAND. Bi-m. Res. Notes 26 (4), 36-7. [2 refs.]
Since 1953 there have been many outbreaks of Stilpnotia salicis (introduced from Europe) in natural stands of P. tremuloides in Newfoundland.

Condrashoff, S. F. 1964. BIONOMICS OF THE ASPEN LEAF MINER. PHYLLOCNISTIS POPULIELLA CHAM. (LEPIDOPTERA: GRACILLARIIDAE). Repr. from Canad. Ent. 96 (6), 857-74. 20 refs.
Information on life history, behaviour, distribution on the host, effects of attack, factors affecting population levels, and the assessment of present and future attacks.

Elliott, K. R., and Wong, H. R. 1966. AN IMPORTANT PREDATOR OF THE ASPEN LEAF BEETLE, CHRYSOMELA CROTCHI BROWN, IN MANITOBA AND SASKATCHEWAN. Bi-m. Res. Notes Dep. For. Can. 22 (5), 3-4.
An account of the life history of a syrphid predator that was responsible for the collapse of a severe outbreak of Chrysomela crotchi on P. tremuloides.

Grimble, D. G. 1969. LIFE TABLES AND MORTALITY FACTORS FOR OBEREA SCHAUMII AND SAPERDA INERNATA (COLEOPTERA: CERAMBYCIDAE) [ON POPULUS TREMULOIDES]. Abstr. of thesis, in Dissert. Abstr. int. 30B (5) 1974. [Order No. 69-18,014. Price M. $3.00; X. $7.60. pp. 161. O.R.S.]

Grimble, D. G., and Knight, F. B. 1970. LIFE TABLES AND MORTALITY FACTORS FOR SAPERDA INORNATA [S. CONCOLOR] (COLEOPTERA: CERAMBYCIDAE). Ann. Ent. Soc. Amer. 63 (5), 1309-19. [12 refs., O.R.S.]
Natural populations of S. inornata were studied at six locations in Michigan.

Grimble, D. G., and Knight, F. B. 1971. MORTALITY FACTORS FOR OBEREA SCHAUMII (COLEOPTERA: CERAMBYCIDAE) [ON POPULUS TREMULOIDES IN N. MICHIGAN]. Ann. Ent. Soc. Amer. 64 (6), 1417-20. [4 ref. ORS] [Cf., FA 32 No. 6469.]

Grimble, D. G., Knight, F. B., and Nord, J. C. 1971. ASSOCIATED INSECTS REARED FROM GALLS OF SAPERDA INORNATA (COLEOPTERA: CERAMBYCIDAE) ON TREMBLING ASPEN IN MICHIGAN. Michigan Entomologist 4 (2), 53-57. [E., 4 ref. From Review of Applied Entomology, A 61, 199.]

Grimble, D. G., Nord, J. C., and Knight, F. B. 1969. OVIPOSITION CHARACTERISTICS AND EARLY LARVAL MORTALITY OF SAPERDA INORNATA [S. CONCOLOR] AND OBEREA SCHAUMII IN MICHIGAN ASPEN. Ann. Ent. Soc. Amer. 62 (2), 308-15. [10 refs. O.R.S.]
An account based on data from theses by Grimble (1966) and Nord (1968).

Hinds, T. E., and Davidson, R. W. 1972. CERATOCYSTIS SPECIES ASSOCIATED WITH THE ASPEN AMBROSIA BEETLE. Mycologia 64 (2), 405-409. [E., 3 ref., ORS]
Describes C. retusi sp.nov., commonly found with C. brevicollis in the pupal cells of the Aspen ambrosia beetle, Trypodendron retusum, in Colorado.

Ives, W. G. H. 1973. HEAT UNITS AND OUTBREAKS OF THE FOREST TENT CATERPILLAR, MALACOSOMA DISSTRIA (LEPIDOPTERA: LASIOCAMPIDAE). Canadian Entomologist 105 (4), 529-543. [E., 35 ref., ORS]
Heat units during a fixed overwintering period and a shifting early larval feeding period for M. disstria were calculated from daily temperature data related to known infestations of the insect where its main host is P. tremuloides.

Knight, F. B., and Nord, J. C. 1972. OBEREA SCHAUMII (COLEOPTERA: CERAMBYCIDAE) IN LARGE TREMBLING ASPEN, POPULUS TREMULOIDES, TO SITE QUALITY. Hypoxylon pruinatum. Great Lakes Entomol. 5 (3): 93-97. [Ref.]

Kusch, D. S. 1967. NOTES ON THE BIOLOGY OF EPINOTIA CRIDDLEANA KFT. Bi-m. Res. Notes Dep. For. Can. 23 (1), 3. [3 refs.]
E. criddleana is common in Ontario and the Prairie States. Its principal host is P. tremuloides.

McGregor, M. D. 1967. BIOLOGY AND NATURAL ENEMIES OF AN ASPEN LEAF TIER, SCIAPHILA DUPLEX, IN THE INTERMOUNTAIN REGION. J. econ. Ent. 60 (5), 1213-6. [9 refs., Smry., 3 photos.]

MacKay, M. R. 1965. THE LARVA OF EPINOTIA CRIDDLEANA KFT. AND A NOTE ON PSEUDEXENTERA OREGONANA WLSHM. (LEPIDOPTERA: TORTICIDAE). Canad. Ent. 97 (6), 666-8. [2 refs., O.R.S.]
Presents a revised description and illustration of the larva of E. criddleana, the eastern Pseudexentera sp. and the western P. oregonana.

Myers, W. L. 1967. DISTRIBUTION OF OVIPOSITION SLITS CONSTRUCTED BY OBEREA SCHAUMII LECONTE AND SAPERDA CONCOLOR LECONTE (COLEOPTERA: CERAMBYCIDAE) ON ASPEN SUCKERS (POPULUS TREMULOIDES MICHAUX). Abstr. of thesis, in Dissert. Abstr. 28B (6), 2209. [O.R.S.]
Studies showed that oviposition frequency per sucker decreased with increasing sucker density.

Myers, W. L., Knight, F. B., and Grimble, D. G. 1968. FREQUENCY OF BORER ATTACKS AS RELATED TO CHARACTER OF ASPEN SUCKER STANDS: A COMPARATIVE STUDY OF OBEREA SCHAUMII AND SAPERDA INORNATA [S. CONCOLOR]. Ann. Ent. Soc. Amer. 61 (6), 1418-23. [7 refs., O.R.S.]

Nord, J. C. 1968. THE LIFE HISTORY AND BEHAVIOR OF SAPERDA INORNATA [S. CONCOLOR] AND OBEREA SCHAUMII (COLEOPTERA: CERAMBYCIDAE) IN TREMBLING ASPEN, POPULUS TREMULOIDES. Abstr. of thesis, in Dissert. Abstr. 29B (4), 1226-7. [O.R.S.]
Describes the life cycle and frequency of Hypoxylon-like cankers associated with borer galleries.

Nord, J. C., Grimble, D. G., and Knight, F. B. 1972. BIOLOGY OF OBEREA SCHAUMII (COLEOPTERA: CERAMBYCIDAE) IN TREMBLING ASPEN, POPULUS TREMULOIDES. Ann. Ent. Soc. Amer. 65 (1), 114-9. [15 ref., ORS]
Describes the biology of O. schaumii in P. tremuloides in Upper Michigan and N. Wisconsin.

Nord, J. C., Grimble, D. G., and Knight, F. B. 1972. BIOLOGY OF SAPERDA INORNATA [S. CONCOLOR] (COLEOPTERA: CERAMBYCIDAE) IN TREMBLING ASPEN, POPULUS TREMULOIDES. Ann. Ent. Soc. Amer. 65 (1), 127-35. [21 ref., ORS]
A biological study of S. inornata in P. tremuloides in Upper Michigan and Wisconsin.

Nord, J. C., and Knight, F. B. 1972. THE DISTRIBUTION OF SAPERDA INORNATA AND OBEREA SCHAUMII (COLEOPTERA: CERAMBYCIDAE) WITHIN THE CROWNS OF LARGE TREMBLING ASPEN, POPULUS TREMULOIDES. Great Lakes Entomologist 5 (1), 28-32. [E., 5 ref., From Review of Applied Entomology, A 63, 3677.]
Aspen crowns in N. Michigan were examined for inhabited galleries and empty ones.

Peterson, L. O. T., and Worden, H. A. 1964. THE EFFECTS OF SYSTEMIC INSECTICIDES ON INJECTED TREES. Extr. from Summ. Rep. For. Nursery Sta. Sask. 1963. (18).
Holes were made at breast height, some left untreated, and others injected with undiluted technical Systox.

Shepherd, R. F., and Brown, C. E. 1971. SEQUENTIAL EGG-BANK SAMPLING AND PROBABILITY METHODS OF PREDICTING DEFOLIATION BY MALACOSOMA DISSTRIA (LASIOCAMPIDAE: LEPIDOTERA). Canad. Ent. 103 (10), 1371-9. [14 ref., ORS]
The sampling system for predicting defoliation of Populus tremuloides by M. disstria is described.

Smereka, E. P. 1965. THE LIFE HISTORY AND HABITS OF CHRYSOMELA CROTCHI BROWN (COLEOPTERA: CHRYSOMELIDAE) IN NORTHWESTERN ONTARIO. Repr. from Canad. Ent. 97 (5), 541-9. 5 refs.
A study of this pest of P. tremuloides.

Smith, G. J., and Raske, A. G. 1968. STARVATION EXPERIMENTS WITH FIRST INSTAR FOREST TENT CATERPILLAR LARVAE. Bi-m. Res. Notes, Ottawa 24 (5), 39. [4 refs.]

Experiment designed to test the length of time that first-instar larvae of Malacosomo disstria can survive without food, and to observe their behaviour.

Stelzer, M. J. 1968. THE GREAT BASIN TENT CATERPILLAR IN NEW MEXICO: LIFE HISTORY, PARASITES, DISEASE, AND DEFOLIATION. U.S. For. Serv. Res. Pap. Rocky Mt. For. Range Exp. Sta. No. RM-39, pp. 16, [13 refs.]
Studies on Malacosoma fragile, epidemic periodically in P. tremuloides stands.

Struble, G. R. 1969. GALL WASP INFESTATIONS IN FOREST TREES, CHIEFLY PINES, OF CALIFORNIA. Repr. from Pan-Pacif. Ent. 45 (2), 112-5. [3 refs.]
The phytophagous gall wasps, Eurytoma spp., are reported to attack Pines and P. tremuloides.

Sugden, B. A. 1966. ANNOTATED LIST OF FOREST INSECTS OF BRITISH COLUMBIA. PART XIII. BREPHINAE, GEOMETRINAE, STERRHINAE, AND LARENTIINAE (GEOMETRIDAE). J. Ent. Soc. B.C. 63, (4, 6-10).

Townes, H. 1965. A NEW CREMASTUS (ICHNEUMONIDAE), PARASITIC ON OBEREA. Pap. Mich. Acad. Sci. 50, (105-6). N.L.L.
Describes C. nordi, reared from O. schaumii boring in P. tremuloides.

Witter, J. A., Kulman, H. M., and Hodson, A. C. 1972. LIFE TABLES FOR THE FOREST TENT CATERPILLAR. Ann. Ent. Soc. Amer. 65 (1), 25-31. [20 ref. ORS]
Data from a study of Malacosoma disstria in P. tremuloides stands in N. Minnesota are tabulated and discussed.

Wong, H. R., and Melvin, J. C. E. 1967. THE LEAF ROLLER PSEUDEXENTERA OREGONANA WLSHM. Bi-M. Res. Notes Dep. For. Can. 23 (1), 3-4. [6 refs.]
Notes on the taxonomy and population fluctuations of this pest of P. tremuloides in western Canada.

Wong, H. R., and Melvin, J. C. E. 1974. INSECTS OF ASPEN CATKINS IN THE CANADIAN PRARIES. Information Report, Northern Forest Research Centre, Canada No. NOR-X-76, 27 pp. [E.f., 18 ref.]
Lists 45 species of insects and 2 species of spiders collected from P. tremuloides catkins.

46 DAMAGE TO TREE GROWTH BY MAN

Zasada, Z. A., and Tappeiner, J. E. 1969. SOIL DISTURBANCE FROM RUBBER-TIRE SKIDDERS DURING SUMMER HARVESTING OF ASPEN. Minn. For. Res. Note No. 204, pp. 3.
A study of four logging operations on silty, sandy and silty clay loams in N. Minnesota using 4-wheel-drive skidders for tree-length or entire-tree harvesting.

48 INJURIES DUE TO UNKNOWN OR COMPLEX CAUSES

Dix, R. L., and Steen, O. A. 1968. ASPEN DIE-BACK IN THE PARKLANDS OF SASKATCHEWAN. Abstr. in Bull. Ecol. Soc. Amer. 49 (2), 81. [A.P.B.]
The dieback is believed to have been caused by the drought of 1963 and sustained by the endemic Cytospora chrysosperma.

5 FOREST MENSURATION

52 MEASUREMENTS OF STEM DIMENSIONS AND VOLUME OF TREES, STANDS, FORESTS AND TIMBER

Alemdag, I. S., and Honer, T. G. 1972. IS DECAY VOLUME STRONGLY RELATED TO NUMBER OF KNOTS AND LOG VOLUME IN POPLAR? Bi-monthly Research Notes 28 (2/3), 18. [E., 3 ref.]

Kirby, C. L. 1965. ACCURACY OF POINT SAMPLING IN WHITE SPRUCE-ASPEN STANDS OF SASKATCHEWAN. J. For. 63 (12), 924-6. 7 refs.

Lothner, D. C., Marden, R. M., and Kallio, E. 1974. WEIGHT-VOLUME RELATIONSHIPS OF ASPEN AND WINTER-CUT BLACK SPRUCE PULPWOOD IN NORTHERN MINNESOTA. USDA Forest Service Research Note, North Central Forest Experiment Station No. NC-174, 4 pp. [E., 9 ref.]
Seasonal weight/volume relations were determined for P. tremuloides and Picea mariana pulpwood.

Valiquette, L. 1964. DIAMETER CONVERSIONS BETWEEN STUMP AND BREAST HEIGHT FOR NORTHERN SPECIES, QUEBEC. Publ. Dep. For. Can. No. 1052, pp. 31. 23 refs. [E.e.f.]
Presents the relationships between d.b.h. and stump diameter.

53 SPECIAL MEASUREMENTS OF TREES AND STANDS (CROWN DIMENSIONS, STAND DENSITY, ETC.)

Peek, J. M. 1970. RELATION OF CANOPY AREA AND VOLUME TO PRODUCTION OF THREE WOODY SPECIES. Ecology 51 (6), 1098-1101. [10 refs.]
Describes a study on P. tremuloides, Corylus cornuta, and Salix discolor.

Pollard, D. F. W. 1970. LEAF AREA DEVELOPMENT ON DIFFERENT SHOOT TYPES IN A YOUNG ASPEN STAND AND ITS EFFECT UPON PRODUCTION. Canad. J. Bot. 48 (10), 1801-4. [6 refs., O.R.S.]
Leaf-area distribution of P. tremuloides was studied to determine the proportion of young foliage in the canopy and to assess its importance for stand productivity.

Steinhilb, H. M., and Erickson, J. R. 1970. WEIGHTS AND CENTERS OF GRAVITY FOR QUAKING ASPEN TREES AND BOLES. U.S. For. Serv. Res. Note Nth. Cent. For. Exp. Sta. No. NC-91, pp. 4. [3 refs.]
In the context of the design of tree-harvesting machines, 97 P. tremuloides trees were weighed.

Telfer, E. S. 1969. WEIGHT/DIAMETER RELATIONSHIPS FOR 22 WOODY PLANT SPECIES. Canad. J. Bot. 47 (12), 1851-5. [10 refs., O.R.S.]
Diameter at ground line was found to be a suitable independent variable in equations for estimating the total dry weight above ground, and weight of foilage.

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Presents data on the dry weight of the whole tree and of its component parts.

54 ASSESSMENT OF SITE QUALITY

Davidov, M. V. 1971. [DIFFERENTIATED SITE-QUALITY CLASSIFICATION AND ITS ROLE IN THE PROBLEM OF IMPROVING THE YIELD OF FORESTS.] Lesnoi Zhurnal 14 (4), 5-9. [Ru., 7 ref.]
Three types of growth are distinguished: (1) normal; (2) rate of height growth declining with age; and (3) rate of height growth increasing with age.

Duffy, P. J. B. 1965. A FOREST LAND CLASSIFICATION FOR THE MIXEDWOOD SECTION OF ALBERTA. Publ. Dep. For. Can. No. 1128. pp. 23. 29 refs. [E.e.f.]
A field survey of description and classification of soils and forest productivity in the accessible part of the mixedwood forest (picea glauca/Populus tremuloides) of Alberta.

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WOOD. Abstr. of thesis, in Dissert. Abstr. int. 31 B (1), 80-1. [Order No. 70 8284. Price: M. $4.00; X. $9.90. pp. 220. ORS]
Includes models for predicting site index from environmental factors, the rate of conversion and other site factors.

Hellum, A. K. 1964. FACTORS INFLUENCING FROND SIZE OF BRACKEN ON SANDY SOILS IN NORTHERN LOWER MICHIGAN. Abstr. of thesis, in Dissert. Abstr. 1967 28B (6), 2207-8. [University of Michigan.] (Order No. 65-5909.)

Jones, J. R. 1966. A SITE INDEX TABLE FOR ASPEN [POPULUS TREMULOIDES] IN THE SOUTHERN AND CENTRAL ROCKY MOUNTAINS. U.S. For. Serv. Res. Note Rocky Mt. For. Range Exp. Sta. No. RM-68, pp. 2. [1 ref.]
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Lundgren, A. L., and Dolid, W. A. 1970. BIOLOGICAL GROWTH FUNCTIONS DESCRIBE PUBLISHED SITE INDEX CURVES FOR LAKE STATES TIMBER SPECIES. U.S. For. Serv. Res. Pap. Nth. Cent. For. Exp. Sta. No. NC-36, pp. 9. [17 refs.]
Two biological growth functions were fitted to published site-index curves.

56 INCREMENT. DEVELOPMENT AND STRUCTURE OF STANDS

Martin, E. C. 1965. GROWTH AND CHANGE IN STRUCTURE OF AN ASPEN STAND AFTER A HARVEST CUTTING. U.S. For. Serv. Res. Note Rocky Mt. For. Range Exp. Sta. No. RM-45, pp. [2]. 1 ref.
Data on increment of a P. tremuloides plot in Arizona after a partial felling.

561 INCREMENT IN HEIGHT

Embry, R. S., and Gotteried, G. J. 1971. BASAL AREA GROWTH OF ARIZONA MIXED CONIFER SPECIES. U.S. For. Serv. Res. Note Rocky Mt. For. Range Exp. Sta. No. RM-198. pp. 3. [2 ref.
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Kozlowski, T. T., and Winget, C. H. 1964. DIURNAL ANI SEASONAL VARIATION IN RADII OF TREE STEMS. Ecolog 45 (1), 149-55. 31 refs.

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Lynn, R. J. 1964. A QUICK METHOD OF DETERMINING AGI OF TREMBLING ASPEN. For. Chron. 40 (2), 256.
An increment core can be heated over a candle flame. Bands of earl wood and darker late wood can then be distinguished.

Maini, J. S., and Coupland, R. T. 1964. A SIMPLE TECHNIQUE FOR AGE DETERMINATION IN TREMBLING ASPEN. For Chron. 40 (2), 219-20, 226. 8 refs.
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562 VOLUME INCREMENT

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566 YIELD TABLES AND THEIR CONSTRUCTION

Gregory, R. A., and Haack, P. M. 1965. GROWTH AND YIELD OF WELL-STOCKED ASPEN AND BIRCH STANDS IN ALASKA. U. S. For. Serv. Res. Pap. Nth. For. Exp. Sta. NOR-2, pp. 28.
Presents yield tables for P. tremuloides and Betula papyrifera in interior Alaska.

Schlaegel, B. E. 1971. GROWTH AND YIELD OF QUAKING ASPEN IN NORTH-CENTRAL MINNESOTA. US For. Serv. Res Pap. Nth. Cent. For. Exp. Sta. NC-58, pp. 11. [10 ref.]
Presents yield tables of total volume and merchantable volume.

6 FOREST MANAGEMENT

65 SPECIAL BUSINESS PROBLEMS OF TIMBER-GROWING

Bradley, C. P., and Biltonen, F. E. 1972. ECONOMIC OPERABILITY – FACTORS AFFECTING HARVEST AND TRANSPORT COSTS. In Aspen Symp. Proc. U. S. For. Serv. Gen. Tech. Rep. NC-1, p. 16-20.

7 MARKETING OF FOREST PRODUCTS.

ECONOMICS OF FOREST TRANSPORT AND THE WOOD INDUSTRIES

72 THE QUANTITATIVE ASPECTS OF MARKETING; DEMAND AND SUPPLY

Leuschner, W. A. 1973. AN ECONOMETRIC ANALYSIS OF THE WISCONSIN ASPEN PULPWOOD MARKET. Forest Science 19 (1), 41-46. [E., 8 ref.]

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79 ECONOMICS OF THE FOREST PRODUCTS INDUSTRIES

Leach, H. A. 1971. COMPUTER ASSESSMENT OF POPLAR USE POTENTIAL IN ONTARIO. For. Chron. 47 (2), 67.

8 FOREST PRODUCTS AND THEIR UTILIZATION

81 WOOD AND BARK: STRUCTURE AND PROPERTIES

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810 GENERAL INFORMATION ON WOODS

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Bowyer, J. L. 1974. AN ANALYSIS OF SELECTED PRODUCTION ALTERNATIVES FOR THE UTILIZATION OF MINNESOTA ASPEN – POPULUS. Univ. Minn. Agricultural Experiment Station Tech. Bull. 299, 23 p. [Ref.]

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811 STRUCTURE. IDENTIFICATION

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812 PHYSICAL AND MECHANICAL PROPERTIES

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Specific gravities were determined from increment cores extracted.

813 WOOD CHEMISTRY

Comtat, J., and Joseleau, J. P. 1973. [PROOF OF 4-0-METHYL-D-GLUCOSE FORM IN 4-0-METHYL GLUCOCURONOXYLAN EXTRACTED FROM POPULUS TREMULOIDES AFTER IN SITU REDUCTION.] Cellul. Chem. Technol. 7 (6): 653-657. Ref. [F.,e.]

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Springer, E. L., and Zoch, L. L. 1966. DELIGNIFICATION OF ASPEN [POPULUS TREMULOIDES] WOOD WITH ACIDIFIED AQUEOUS SOLUTIONS OF SULFOLANE. Svensk PappTidn. 69 (16), 513-6. [11 refs. [E.e.sw.g.].]
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Abramovitch, R. A., and Koleoso, O. A. 1966. SOME STEAM-VOLATILE COMPONENTS OF THE [BENZENE] EXTRACTIVES FROM POPULUS TREMULOIDES HEARTWOOD. Canad. J. Chem. 44 (23), 2913-5. [4 refs. O.R.S.]
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815 EFFECT OF GROWTH FACTORS ON STRUCTURE AND PROPERTIES

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82 CONVERSION, SHAPING, ASSEMBLY AND FINISHING OF WOOD: GENERAL

Peters, C. C., Mergen, A. F., and Panzer, H. R. 1969. SLICIN WOOD ONE-INCH THICK: FOUR TYPES OF PRESSURE BAR Forest Prod. J. 19 (7): 47-52.

821 BARKING

Peters, C. C. 1968. MULTIPLE-FLITCH METHOD FOR THIC SLICING. Forest Prod. J. 18 (9): 82-83.

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Discusses various methods of segregating bark from chips. In o study, 100% segregation of Aspen bark was obtained. Combinatio of several methods may be needed in practice.

Erickson, J. R. 1972. THE STATUS OF METHODS FOR DI BARKING WOOD CHIPS. Tappi 55 (8), 1216-1220. [E., 15 ref.]
Reviews the merits of barking by air-flotation, liquid-mediu flotation and compression methods, and of mechanical treatmen complementary to these methods.

Hass, B. R., and Kremers, R. E. 1964. LOOSENING BARK FRO PULPWOOD WITH DILUTE ACIDS. Tappi 47 (11), 726-8. 5 ref
Bark of disks from saplings or branches peeled satisfactorily aft treatment with 2·0 N H_2SO_3 or 0·5-2·0 N HCl, H_2SO_4, oxalic sulphamidic acid, at room temperature for 4-44 hr.

Mattson, J. A. 1974. COMPRESSION DEBARKING OF STORE WOOD CHIPS. USDA Forest Service Research Note, North Centr Forest Experiment Station NC-161, 4 pp. [E., 5 ref.]
Reports tests with a compression method of removing bark fro chips of P. tremuloides (boles) and Pinus banksiana (whole stem that had been chipped with bark on and stored for a year.

822 SAWS AND SAWING (DESCRIPTION AND INVESTIGATIONS OF INDIVIDUAL MACHINES AND THEIR FUNCTIONS)

Hill, F. J. 1972. AN ECONOMIC EVALUATION OF CHIPPE CANTER ASPEN PRODUCTION. [Abstract.] Dissertation A stracts International, B. 33 (5): 1889-1890. [E., ORS, Order N 72-27, 759.]
Describes the development of a model which simulates productio and evaluates the economics of chipper/canter headrig sawmills converting data on inputs of logs of P. tremuloides into outputs lumber, chips and sawdust.

Robichaud, Y., Petro, F. J., and Kingsley, M. C. S. 1974. ASPE LUMBER AND DIMENSION STOCK RECOVERY IN RELATIO TO SAWING PATTERN. Forest Products Journal 24 (3): 26-3 [E., 3 ref.]

Thompson, R. D. 1972. ASPEN STUDS PRODUCED ON CHI PING HEADRIG. Forest Industries 99, 60-62. [E., 4 ref., NLL]
Results are encouraging, though further experience is necessa

efore firm decisions can be made on the feasibility of using the 'hip-N-Saw for the production of Aspen studs.

823 PLANING, CUTTING OF MOULDINGS. CHILSELLING, MORTISING AND TENONING. BORING. TURNING

.rola, R. A. 1971. CROSSCUT SHEARING OF ROUNDWOOD ;OLTS. USDA Forest Service Research Paper, North Central Forest :xperiment Station NC-68, 20 pp. [E., 14 ref.]
)escribes a study on frozen and unfrozen logs, comparing various ypes of shear blade and anvil.

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;tewart, H. A. 1971. CROSS-GRAIN KNIFE PLANING IM-'ROVES SURFACE QUALITY AND UTILIZATION OF ASPEN. 'JS Forest Service Research Note, North Central Forest Experiment ;tation NC-127, 4 pp. [E., 3 ref.]

825 CLEAVING. ADZING. MECHANICAL COMMINUTION

:rickson, J. R. 1968. BARK SEPARATION DURING CHIPPING VITH A PARALLEL KNIFE CHIPPER. U.S. For. Serv. Res. Note Nth. Cent. For. Exp. Sta. NC-54, pp. 3. [6 refs.]
Chipping in the woods and segregating the bark would permit itilization of crooked tops, limbs etc. that are present uneconomic o harvest. With suitable 'after-chipping' bark-removal methods, emote chipping could be a means of a larger supply of pulpwood.

ulien, L. M., Edgar, J. C., and Conder, T. M. 1972. SEGRE-GATION OF ASPEN, BALSAM, AND SPRUCE WOOD AND BARK CHIPS BASED ON DENSITY DIFFERENCES. Forest Products Journal 22 (6): 56-59. [E., 9 refs.]
The density-gradient technique was used to measure the density of chips. At equal moisture contents, the densities of bark chips of P. remuloides, Abies balsamea and Picea glauca were greater than those of the corresponding wood chips. Bark and wood chips were effectively segregated by soaking the green, air-dried or oven-dried chips for 0-72 hours.

Sturos, J. A. 1972. DETERMINING THE TERMINAL VELOCITY OF WOOD AND BARK CHIPS. US Forest Service Research Note, North Central Forest Experiment Station NC-131, 4 pp. [E., 7 ref.]
Significant differences in the values for wood and bark indicate that air flotation is a promising method of separation.

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Mattson, J. A. 1974. BENEFICIATION OF COMPRESSION DE-BARKED WOOD CHIPS. USDA For. Serv. Res. Note. North Cent. For. Exp. Stn. NC-180, 4 p.

83 TIMBER MANUFACTURING INDUSTRIES AND PRODUCTS

832 MILLS, THEIR FUNCTIONS AND PRODUCTS

832.1

Bailey, G. R. 1973. ASPEN: FRAMING LUMBER YIELDS HIGH, BUT DRYING A PROBLEM. Canadian Forest Industries 93 (12), 43-49. [E., 3 ref., NLL]
Yields of good-quality lumber were high, but only 78% of the number of pieces kiln-dried after 8 weeks of air drying in summer had moisure contents of ⟨ 19%.

Bailey, G. R. 1973. LUMBER GRADE RECOVERY FROM STRAIGHT ASPEN LOGS. Forest Products Journal 23 (4), 47-54. [E., 4 ref.]

832.2

Bulgrin, E. H., McDonald, K. A., and Vaughan, C. L. 1966. VENEER YIELDS FROM LAKE STATES QUAKING ASPEN. U.S. For. Serv. Res. Pap. U.S. For. Prod. Lab., Madison FPL59, pp. 7. [1 ref.]

Feihl, O., and Godin, V. 1966. VENEER AND PLYWOOD FROM ASPEN POPLAR. Publ. Dep. For. Can. No. 1157, pp. 6 [4 refs. [E.e.f.].]
Results show that it can be cut without heat treatment.

Koch, C. B. 1966. EFFECT OF COMPRESSION ON MOISTURE CONTENT AND SORPTION HYSTERESIS OF ASPEN [POPULUS TREMULOIDES] PLYWOOD. For. Prod. J. 16 (10), 57-60. [2 refs.]
Seven-ply specimens were compressed for 1 or 10 hr. to thickness down to 45% of the original.

834 SHINGLES. COOPERAGE. PACKING CONTAINERS. (MANUFACTURE AND USE)

Stern, E. G. 1974. DESIGN OF PALLET DECKBOARD-STRINGER JOINTS. PART 1: ASPEN-PALLET JOINTS AND ASPEN PALLETS. [Bulletin], Wood Research and Wood Construction Laboratory, Virginia Polytechnic Institute and State University No. 126, 47 pp. [E., 7 ref.]
Wood was tested for suitability for pallets and various types of stringer joints.

839 MISCELLANOUS

Heaney, D. P., and Bender, F. 1970. THE FEEDING VALUE OF STEAMED ASPEN FOR SHEEP. For. Prod. J. 20 (9), 98-102. [18 refs.]
Results of a fattening trial with rations containing ca. 45% wood indicate that this product can replace hay completely in mixed, finishing-type diets.

Heaney, D. P., Bender, F., and Lister, E. 1973. USE OF STEAMED ASPEN POPLAR IN A FINISHING RATION FOR HOLSTEIN STEERS. Can. J. Anim. Sci. 53 (4): 739-740.

84 PRESERVATION AND OTHER TREATMENTS TO IMPROVE THE PROPERTIES OF WOOD. DAMAGING INFLUENCES

841 WOOD PRESERVATION

Behr, E. A. 1964. PRESERVATIVE TREATMENT OF POSTS WITH DRY CHEMICALS. For. Prod. J. 14 (11), 511-5. 10 refs.

Krzyzewski, J. 1964. AN EASY WAY TO PRESERVE FENCE-POSTS BY SAP DISPLACEMENT. Publ. Dep. For. Can. No. 1076, pp. 10. [E.e.f.]
Suggestions are made for subsequent slow drying (to help fix the preservative) which, if properly followed, should give a service life of 10-15 years vs. 3-6 years for untreated posts.

842 TREATMENTS TO IMPROVE THE RESISTANCE OF WOOD TO PHYSICAL AND CHEMICAL AGENCIES

Beall, F. C. 1972. DIMENSIONAL STABILIZATION OF WOOD WITH DIMETHYL SULFONE AT 25° C. Wood and Fiber 4 (1) 49-53 [E., 5 ref.]
With a saturated solution, a 50% reduction in volumetric shrinkage was obtained, and nearly 80% of the shrinkage occurred between 100% and 70% r.h.

Beall, F. C., Witt, A. E., and Bosco, L. R. 1973. HARDNESS AND HARDNESS MODULUS OF WOOD-POLYMER COMPOSITES. Forest Products Journal 23 (1) 56-60 [E., 3 ref.]

843 FIREPROOFING AND FIRE RESISTANCE

Arsenault, R. D. 1964. FIRE-RETARDANT PARTICLE BOARD FROM TREATED FLAKES. For. Prod. J. 14 (1), (33-9). 10 refs.
Aspen boards made from flakes soaked in D : P, an equimolar solution of dicyandiamide and H_3PO_4, combined good flame and glow resistance with only slight loss of internal bond and bending strength.

844 ATTACK BY PLANT ORGANISMS

844.1

Stranks, D.W. 1968. GROWTH OF AUREOBASIDIUM PULLULANS ON BALL-MILLED ASPEN. Bi-m. Res. Notes Dep. For. Can. 24 (2), (17-8). [3 refs.]
The growth on wood of the fungus was chiefly at the expense of wood hemicellulose or the O-acetyl-4-O-methyl-glucurone-xylan fraction, which comprises 24% of Aspen wood weight.

844.2

Merrill, W., French, D.W., and Wood, F. A. 1964. DECAY OF WOOD BY SPECIES OF THE XYLARIACEAE. Phytopathology 54 (1), (56-8). 4 refs.

Merrill, W. 1965. DECAY OF WOOD BY DIKARYOTIC, MONOKARYOTIC, AND ILLEGITIMATE HETEROKARYOTIC ISOLATES OF TRAMETES HISPIDA. Abstr. in Phytopathology 55 (2), (130).
In general, monokaryotic isolates caused the greatest weight losses.

Merrill, W., and French, D.W. 1964. PARTICLE SIZE ALTERS CELLULOSE YIELD IN WOOD DECAYED BY LENZITES TRABEA. For. Prod. J. 14 (5), (228). 3 refs.

Merrill, W., and French, D.W. 1966. DECAY IN WOOD AND WOOD FIBER PRODUCTS BY SPOROTRICHUM PRUINOSUM. Mycologia 58 (4), (592-6). [10 refs. O.R.S.]

845 ATTACK BY ANIMALS

845.3

Matsumura, F., Tai, A., and Coppel, H.C. 1969. TERMITE TRAIL-FOLLOWING SUBSTANCE, ISOLATION AND PURIFICATION FROM RETICULITERMES VIRGINICUS AND FUNGUS-INFECTED WOOD. J. econ. Ent. 62 (3), (599-603). [6 refs.]
Chromatographic and spectroscopic tests proved that the termite attractant in wood (P. tremuloides) rotted by Lenzites trabea is identical with the termites' own trail-following substance.

847 DRYING (SEASONING)

Chow, S.-Z. 1971. DETERMINING VENEER SURFACE INACTIVATION BY A REFLECTANCE COLORIMETER. For. Prod. J. 21 (2), (19-24). [3 refs.]
Colour changes occurring in veneers during high-temperature drying were correlated with a decline in shear strength of plywood made from them.

Danielson, C.W. 1972. REGIONAL ACTIVITIES AND DRYING PROBLEMS IN THE WISCONSIN-MICHIGAN WOOD SEASONING ASSOCIATION AREA. Forest Prod. J. 22 (7): 17-19.

Erickson, R., and Demaree, L. 1972. THE DRYING OF PREDRILLED ASPEN LUMBER. Forest Prod. J. 22 (11): 48-50.

Hann, R. A. 1966. AN INVESTIGATION OF THE DRYING OF WOOD AT TEMPERATURES ABOVE 100 DEGREES CENTIGRADE. Abstr. of thesis, in Dissert. Abstr. 26 (8), (4146-7). [O.R.S.]
Aspen generally dried without defects, though there was occasional collapse in the 'wet zone' between heartwood and sapwood.

Huffman, D. R. 1972. KILN-DRYING ASPEN STUDS. Forest Products Journal 22 (10) 21-23 [E., 5 ref.]
None of the methods was satisfactory for lumber containing wetwood.

Mackay, J. F. G. 1974. HIGH-TEMPERATURE KILN-DRYING OF NORTHERN ASPEN 2- by 4-INCH LIGHT FRAMING LUMBER. Forest Products Journal 24 (10) 32-35 [E., 3 ref.]

848 TIMBERYARD PRACTICE. HANDLING AND STORAGE OF TIMBER

Erskine, W.C., and Galganski, R.T. 1967. EFFECTS OF OUTDOOR STORAGE IN CHIP FORM ON NORTHERN ASPEN PULPED BY THE SULPHITE PROCESS. Tappi 50 (10), (477-82). [10 refs.]

Feist, W.C., Hajny, G.J., and Springer, E.L. 1973. EFFECT OF STORING GREEN WOOD CHIPS AT ELEVATED TEMPERATURES. Tappi 56 (8) 91-95 [E., 16 ref.]
A study on the effects of heat on wood properties and on pulps prepared from green wood stored outdoors in large chip piles showed that degradation of the wood occurred after only 3 months' storage.

Feist, W.C., Springer, E.L., and Hajny, G.J. 1973. SPONTANEOUS HEATING IN PILED WOOD CHIPS – CONTRIBUTION OF BACTERIA. Tappi 56 (4) 148-151 [E., 21 ref.]
Large numbers of aerobic bacteria were found during the initial and the second heating stages in 6-month storage experiments.

Springer, E.L., Feist, W.C., Zoch, L.L., Jr., and Hajny, G.J. 1973. EVALUATION OF CHEMICALS FOR PRESERVING WOOD CHIPS USING PILE SIMULATORS. Tappi 56 (6) 125-128 [E., 6 ref.]

85 "GRADING" OF WOOD AND WOOD PRODUCTS

852 DETECTION, RECOGNITION AND ASSESSMENT OF INJURIES AND DEFECTS

Embry, R.S., and Gollfried, G.J. 1971. FREQUENCY OF S FEATURES AFFECTING [TIMBER] QUALITY IN ARIZONA MIXED CONIFERS. U.S. For. Serv. Res. Pap. Rocky Mt. For. Range Exp. Sta. RM-70, pp. 19. [2 ref.]

Haygreen, J.G., and Wang, S.-S. 1966. SOME MECHANICAL PROPERTIES OF ASPEN WETWOOD. For. Prod. J. 16 (9), (118-9). [1 ref.]
The moisture content of wetwood was ca. 50% higher than that of radially or laterally adjoining normal sapwood, and its density, dimensional stability, strength properties and elasticity were lower.

Hill, F.J., Bowyer, J.L., and Haygreen, J.G. 1971. THE SIZE AND QUALITY OF WOODSRUN ASPEN BOLTWOOD IN NORTHERN MINNESOTA. Minn. For. Res. Note No. 230, pp. 4.

Hook, D.D., and Sucoff, E. [I.]. 1966. PREDICTING DISCOLORATION IN WOOD OF QUAKING ASPEN. Minn. For. Note No. 169, pp. [2]. [9 refs.]
Dark wood in P. tremuloides is associated with decay, wounds penetrating through the bark into the xylem, and branch/stem intersections.

Knutson, D.M. 1969. WETWOOD IN TREMBLING ASPEN (POPULUS TREMULOIDES MICHX.). Abstr. of thesis, in Dissert. Abstr. int. 1969 30B (2), (455-6). [Order No. 69-11,417.]
Wetwood is a physiological disease of sapwood, initiated by living cells as a response to irritation, by the production of tyloses and gums, the consequent accumulation of mineral salts, and the development of high moisture content and pH.

Nekrasova, G.N. 1967. [ANATOMICAL AND HISTOCHEMICAL FEATURES OF FALSE HEART IN ASPEN.] In Materialy k naucno-tehniceskoj konferencii (Maj 1967 goda). Lesotehniceskaja Akademija, Leningrad. pp. 32-5. [11 refs. [Ru.e.].]
Gives notes on the various kinds of false heart. Only the cinnamon-brown and rusty false hearts have a pathological (fungal) origin.

852.1

Sucoff, E., Ratsch, H., and Hook, D.D. 1967. EARLY DEVELOPMENT OF WOUND-INITIATED DISCOLORATION IN POPULUS TREMULOIDES. Canad. J. Bot. 45 (5), (649-56 + 8 photos). [12 refs. [E.e.f.].]

86 PULP INDUSTRIES

861 PULP AND PAPER MANUFACTURE. TEXTILE AND OTHER CELLULOSE DERIVATIVES

Allan, R.S., Skeet, C.W., and Forgacs, O.L. 1968. REFINER GROUNDWOOD FROM DECIDUOUS SPECIES. Pulp Paper Mag. Can. 69 (18, Sept. 20), (74-80). [8 refs.]
The feasibility of producing newsprint-grade mechanical and chemimechanical pulps from Canadian hardwoods is discussed.

ella, I. E., and Hunt, K. 1973. KRAFT PULPING OF YOUNG REMBLING ASPEN FROM MANITOBA. Canadian Journal of orest Research 3 (3) 359-366 [E.f., 23 ref.]
he quality and yield of pulp from 7-, 13- and 22-year-old trees of . tremuloides are almost the same, and are comparable to those of ommercial hardwood/softwood pulp.

enson, M. K., and Peckham, J. R. 1968. PRELIMINARY OBERVATIONS ON A BARK AND WOOD-CHIP SEPARATION ROCEDURE FOR ASPEN. Genet. Physiol. Note Inst. Paper hem., Appleton, Wis. No. 2, pp. 7. [8 refs.]
flotation method of separating bark and wood from P. emuloides chips is described.

hase, A. J., Hyland, F., and Young, H. E. 1971. PUCKERBRUSH ULPING STUDIES. Technical Bulletin, Life Sciences and Agriulture Experiment Station, University of Maine, Orono No. 49, pp. 4. [13 ref.]
eports encouraging results of tests to determine whether acceptble sulphate pulps could be produced from 'puckerbrush'.

lermont, L. P. 1970. DELIGNIFICATION OF ASPEN WOOD VITH AQUEOUS SULFOLANE SOLUTIONS. Tappi 53 (12), 2243-5). [8 refs.]
eports the efficient delignification of Aspen wood by cooking in queous 'sulfolane' (tetramethylene-sulphone) solutions.

inspahr, D. W., Peckham, J. R., and Benson, M. K. 1970. FIBER ND PULP PROPERTIES OF TRIPLOID AND TRIPLOID YBRID ASPEN. Tappi 53 (10), (1853-6). [17 refs.]

ardner, H. S., and Einspahr, D. W. 1964. REPRODUCIBILITY OF IICROPULPING WOOD SAMPLES. Tappi 47 (7), (432-4). 6 refs.

lunt, K., and Keays, J. L. 1973. KRAFT PULPING OF REMBLING ASPEN TOPS AND BRANCHES. Canadian Journal f Forest Research 3 (4) 535-542 [E.f., 24 ref.]
Inmerchantable tops and branches of P. tremuloides with and ithout bark, gave unbleached sulphate pulps with greater permanganate numbers and screen rejects than pulps from corresponding boles when cooked by the same schedule.

lunt, K., and Keays, J. L. 1973. SHORT-ROTATION REMBLING ASPEN TREES (POPULUS TREMULOIDES IICHX.) FOR KRAFT PULP. Canadian Journal of Forest Research , 180-184 [E.f., 17 ref.]

eays, J. L. 1967. THE USE OF TREMBLING ASPEN IN PULP ND PAPER MANUFACTURE. Inform. Rep. For. Prod. Lab., ancouver No. VP-X-18, pp. 18 [1 gph. [1 ref. P.R.].]
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eays, J. L. 1968. PRESENT AND FUTURE USE OF ASPEN IN ULPING. Inform. Rep. For. Prod. Lab., Vancouver No. VP-X-36, p. 18. [1 ref. P.R.]
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eask, R. A. 1968. CHEMIMECHANICAL PULPS FROM HARDVOODS. Tappi 51 (12), (117A-120A). [3 refs.]

immonds, F. A., and Hyttinen, A. 1964. TWO-STAGE NONHLORINATION BLEACHING OF SEVERAL HARDWOOD IEUTRAL SULFITE SEMICHEMICAL PULPS. U.S. For. Serv. es. Note U.S. For. Prod. Lab., Madison No. FPL-043, pp. 5 + 6 bls.

springer, A. M., and Thompson, N. S. 1971. A MATHEMATICAL IODEL FOR THE RATE OF EXTRACTION OF XYLAN FROM VOOD CHIPS [OF POPULUS TREMULOIDES WITH KRAFT OOKING LIQUOR.] Pap. ja Puu 53 (9), (499-510). [E.fin., 2 ref. R]

springer, E. L., and Zoch, L. L., Jr. 1971. DELIGNIFYING ASPEN VOOD WITH AQUEOUS XYLENESULFONIC ACID AT 100° C. appi 54 (12), (2059-60). [3 ref.]
eports promising results of a procedure for delignifying P. remuloides wood with solutions of pure xylenesulphonic acid.

Thompson, N. S., and Kaushnen, O. A. 1970. MODIFICATION OF THE PHYSICAL PROPERTIES OF TRACHOIDS AND PULPS PREPARED FROM CONIFEROUS CHLORITE HOLOCELLULOSE. Tappi 53 (8), (1502-6). [25 refs.]

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Arola, R. A. 1974. COMPARISON OF WET AND OVENDRY ANALYSES OF COMPRESSION DEBARKING TESTS ON WOOD CHIPS. USDA For. Serv. Res. Note NC-178, 4 p. North Cent. For. Exp. Stn., St. Paul, Minn.

Hatton, J. V. 1973. DEVELOPMENT OF YIELD PREDUCTION EQUATIONS IN KRAFT PULPING. Tappi 56 (7): 97-100. Ref.

Hatton, J. V., and Hejjas, J. 1972. EFFECTS OF TIME, TEMPERATURE AND EFFECTIVE ALKALI IN KRAFT PULPING OF TREMBLING ASPEN (POPULUS TREMULOIDES MICHX.) Pulp Pap. Mag. Can. 73 (9): 74-78. Ref.

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Nicholls, G. A., Peckham, J. R., and Van Drunen, V. J. 1972. SOME EFFECTS OF AN ALKYLPEROXIDE IN HIGH-YIELD PULPING OF ASPEN. Tappi 55 (9): 1369-1376. Ref.

862 COMPOSITE MATERIALS MADE WHOLLY OR PARTLY OF WOODY MATTER

Bonner, L. D. 1966. FLAKEBOARD PRODUCED FROM POLYETHYLENE GLYCOL TREATED [ASPEN] FLAKES. Abstr. of thesis, in For. Prod. J. 16 (12), (48).

Gertjejansen, R. 1969. WET PROCESS HARDBOARDS FROM ASPEN SAPWOOD AND DISCOLORED HEARTWOOD. For. Prod. J. 19 (9), (103-7). [5 refs.]
The characteristics of discoloured heartwood, often comprising 30-60% of the stem volume, are described. Hardboards made from refiner groundwood pulps showed the sapwood boards to have higher strength but lower dimensional stability in thickness.

Gertjejansen, R., and Haygreen, J. 1973. THE EFFECT OF ASPEN BARK FROM BUTT AND UPPER LOGS ON THE PHYSICAL PROPERTIES OF WAFER-TYPE AND FLAKE-TYPE PARTICLEBOARDS. Forest Products Journal 23 (9) 66-71 [E., 2 ref.]

Gertjejansen, R., Hyvarinen, M. [Hyvarinen, M. J.], Haygreen, J., and French, D. 1973. PHYSICAL PROPERTIES OF PHENOLIC BONDED WAFER-TYPE PARTICLEBOARD FROM MIXTURES OF ASPEN, PAPER BIRCH, AND TAMARACK. Forest Products Journal 23 (6) 24-28 [E., 2 ref.]

Gertjejansen, R. O., Haygreen, J. G., and French, D. W. 1972. PARTICLEBOARD FROM ASPEN FLAKES AND SUNFLOWER HULLS. Tech. Bull No. 290, Forestry Series 10, Univ. of Minn. Agr. Exp. Sta.

Sinclair, G. D., and Dymond, D. K. 1968. HARDBOARDS FROM POPLAR WOOD. Tappi 51 (9), (108A-111A). [12 refs.]

Stayton, C. L., et al. 1971. ASPEN AND PAPER BIRCH MIXTURES AS RAW MATERIAL FOR PARTICLE BOARD. For. Prod. J. 21 (12), (29-30). [8 ref.]
Strength and dimensional stability were slightly reduced (in comparison with boards made of pure Aspen). All boards were above minimum commercial standards.

Steinmetz, P. E., and Fahey, D. J. 1971. EFFECT OF MANUFACTURING VARIABLES ON STABILITY AND STRENGTH OF WET-FORMED HARDBOARDS. US For. Serv. Res. Pap. US For. Prod. Lab., Madison No. FPL 142, pp. 7. [1 ref.]

Suchsland, Otto, and Enlow, R. C. 1968. HEAT TREATMENT OF EXTERIOR PARTICLEBOARD. Forest Prod. J. 18 (8): 24-28.

863 WOOD HYDROLYSIS. SACCHARIFICATION

Korolkov, I. I., Lihonos, E. F., and Sahanova, R. K. 1967. [THE COURSE OF FORMATION OF VARIOUS PRODUCTS DURING THE HYDROLYSIS OF PLANT MATERIAL.] Gidrol. lesohim. Prom. 20 (6), (8-10). [Ru.]

89 OTHER FOREST PRODUCTS

892 VEGETABLE PRODUCTS

Pearl, I. A., and Darling, S. F. 1967. STUDIES ON THE BARKS OF THE FAMILY SALICACEAE. XIV. FURTHER STUDIES ON THE BARK OF TRIPLOID POPULUS TREMULOIDES. Tappi 50 (7), (324-9). [28 refs.]

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Enzmann, J. W., Goodrich, R D., and Meiske, J. C. 1969. CHEMICAL COMPOSITION AND NUTRITIVE VALUE OF POPLAR BARK. Journal of Animal Science, Fort Collins 29 (4), (653-60). [From abstr. in Herb. Abstr. 1970, 40 (2), (No. 954).]
Results of a feeding trial with sheep indicated that P. tremuloides bark silage was not a very suitable energy source compared with poor-quality hay or straw.

Jiang, K. S., and Timell, T. E. 1972. POLYSACCHARIDES IN BARK OF ASPEN (POPULUS TREMULOIDES). (1) ISOLATION AND CONSTITUTION OF A 4-O-METHYLGLUCURONOXYLAN. (2) ISOLATION AND STRUCTURE OF AN ARABINAN. (3) CONSTITUTION OF A GALACTOGLUCOMANNAN. Cellulose Chemistry & Technology 6 (5) 493-505 [E.] From Abstract Bulletin of the Institute of Paper Chemistry 44, 2940-2. LTP.

Pearl, I. A., and Darling, S. F. 1971. HOT WATER PHENOLIC EXTRACTIVES OF THE BARK AND LEAVES OF DIPLOID POPULUS TREMULOIDES. Phytochemistry 10 (2), (483-4). [3 ref. (Studies on the barks of the family Salicaceae XXVII. Studies on the leaves of the family Salicaceae XIV). ORS]

Pearl, I. A., and Estes, T. K. 1965. STUDIES ON THE HOT WATER EXTRACTIVES OF THE BROWN BARK OF POPULUS TREMULOIDES. Tappi 48 (9), (532-5). 15 refs.

9 FORESTS AND FORESTRY

FROM THE NATIONAL AND INTERNATIONAL POINTS OF VIEW

90 GENERAL

Page, G. 1972. THE OCCURRENCE AND GROWTH OF TREMBLING ASPEN IN NEWFOUNDLAND. Publ. Dep. Environ. Can. For. Serv. 1314, 15 p. Ref.

Einspahr, D. W. 1974. THE FUTURE SUPPLY OF ASPEN AND OTHER HARDWOODS IN THE LAKE STATES REGION [OF THE USA]. Tappi 57 (8) 93-95 [E., 9 ref.]

94 METHODS TO IMPLEMENT FOREST POLICY

USDA Forest Service. 1972. ASPEN: SYMPOSIUM PROCEEDINGS. USDA Forest Service General Technical report, North Central Forest Experiment Station. No. NC-1, 154 pp. [E.]

P. TRICHOCARPA TO P. YUNNANENSIS

0 GENERAL

Muller, R. 1970. [PRINCIPLES FOR JUDGING TRICHOCARPA POPLAR.] Forstpflanzen-forstsamen 10 (2): 6-12, 41-42. [G.]

1 FACTORS OF THE ENVIRONMENT. BIOLOGY

16 GENERAL BOTANY

160 PLANT CHEMISTRY

Dormaar, J. F. 1970. SEASONAL PATTERN OF WATER-SOLUBLE CONSTITUENTS FROM LEAVES OF POPULUS X 'NORTHWEST' (HORT.). J. Soil Sci. 21 (1), (105-10). [17 refs.]

Glattes, F. 1971. [STUDIES ON THE INHIBITOR CONTENT OF SOME POPLAR CLONES BY THIN-LAYER CHROMATOGRAPHY AND MICROBIOLOGICAL METHODS.] Europ. J. For. Path. 1 (2), (65-80). [De.e.f., 18 ref.]
The extracts were tested in vitro for their effect on mycelial growth of Septotinia podophyllina (S. populiperda) and Dothichiza populea.

Plouvier, V. 1967. [A STUDY OF THE FLAVONIC HETEROSIDES OF FRAXINUS AND TILIA SPP. AND SOME OTHER PLANTS: FRESH SPECIES CONTAINING RHOIFOLIN, LINARIN, DIOSMIN, HESPERIDIN AND KAEMPFERITRIN.] C.R. Acad. Sci., Paris 265D (21), (1647-50). [8 refs. [F.f.] O.R.S.]

Sosa, F., and Percheron, F. 1970. [KAEMPFEROL-3-O-RHAMNODIGLUCOSIDE, A NEW HETEROSIDE FROM THE POLLEN OF POPULUS YUNNANENSIS.] Phytochemistry 9 (2), (441-6). [F.e., 14 refs. O.R.S.]

161 PHYSIOLOGY

Dykstra, G. F. 1974. NITRATE REDUCTASE ACTIVITY AND PROTEIN CONCENTRATION OF TWO POPULUS CLONES. Plant Physiology 53 (5) 632-634 [E., 18 ref. OBD]
The difference in nitrate reductase activity between clones was probably due to a genetically determined ability to synthesize nitrate reductase in response to NO_3^-.

Pollard, D. F. W., and Wareing, P. F. 1968. RATES OF DRY-MATTER PRODUCTION IN FOREST TREE SEEDLINGS. Ann. Bot., Lond. 32 (127), (573-91). [24 refs. O.B.D.]

Rutkovskii, I. V. 1973. [THE BIOELECTRIC ACTIVITY OF POPLARS OF DIFFERENT PHYSIOLOGICAL CONDITION IN DAILY AND SEASONAL RHYTHMS.] Lesovedenie No. 1, 51-57 [Ru.e., 13 ref.]
Studies on two 8-year P. trichocarpa trees of widely differing external characteristics. Results demonstrated the existence of both daily and seasonal rhythms in bioelectric activity which could be correlated with physiological condition, and indicated that their use for the diagnosis of vitality is promising.

Starova, N. V., and Eremenko, E. A. 1970. [SEXUAL SPECIALIZATION IN POPLARS.] Bjull. Glavn. Bot. Sada No. 75, (31-7). [Ru. 16 refs. N.L.L.]

Among the progeny of P. trichocarpa X P. laurifolia, one ♀ specimen was found, and the ♀ condition was maintained in the vegetative progeny of this individual. A study of the flowers and pollen showed that all the flowers of the ♀ were normally developed. Ratio of leaf length to width was a reliable indicator of sex even in the juvenile stage. When all the 1-year shoots were removed from a ♂ clone of P. nigra var. italica X P. trichocarpa for two successive years, many of the trees changed sex; ♀ clones similarly treated did not change.

161.6

Stettler, R. F. 1971. VARIATION IN SEX EXPRESSION OF BLACK COTTONWOOD AND RELATED HYBRIDS. Silvae Genet. 20 (1/2), (42-6). [E., 26 ref.]

164 MORPHOLOGY

Bawa, K. S., and Stettler, R. F. 1972. ORGAN CULTURE WITH BLACK COTTONWOOD: MORPHOGENETIC RESPONSE OF FEMALE CATKIN PRIMORDIA. Canadian Journal of Botany 50 (7) 1627-1631 + 1 pl. [E.f., 13 ref. ORS]

Clausen, J. J., and Kozlowski, T. T. 1965. HETEROPHYLLOUS SHOOTS IN BETULA PAPYRIFERA. Nature, Lond. 205 (4975), 1030-1). 1 ref.
Apparently early leaves overwintered as large embryonic leaves, whereas late leaves overwintered either as small embryonic leaves or as primordia.

164.6

Bosa, F., and Percheron, F. 1970. [KEMPFEROL-3-O-RHAMNODIGLUCOSIDE, A NEW HETEROSIDE FROM THE POLLEN OF POPULUS YUNNANENSIS.] Phytochemistry 9 (2), (441-6). [F.e., 14 refs. O.R.S.]

165 PHYLOGENY, EVOLUTION, HEREDITY, GENETICS AND BREEDING, VARIATION

Muller, R. 1970. URTEILSGRUNDLAGEN FUR DIE TRICHOCARPA-PAPPEL. 2. DIE TRICHOCARPA-PAPPEL IN DEUTSCHLAND BIS 1950. Forstpflanzen-Forstsamen, Strassenhaus/Neuwied 10, 1, 8-16, 37-47, 6 Abb., 2 graph. Darst., 6 Tab., 51 Lit. Ang., engl. Zsfg.

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Mohn, C. A. 1969. A STUDY OF THE GENETIC CONTROL OF SHOOT GROWTH PATTERNS IN POPULUS TRICHOCARPA. Abstr. of thesis, in Dissert. Abstr. int. 30B (4), (1440-1). [Order No. 69-16,430. pp. 91. O.R.S.]
The population studied consisted of first- and second-generation progeny from two parents. The genetic variation indicates that there are considerable possibilities of modifying growth curves by selection and breeding, without loss of vigour.

Stettler, R. F. 1968. IRRADIATED MENTOR POLLEN: ITS USE IN REMOTE HYBRIDIZATION OF BLACK COTTONWOOD. Nature, Lond. 219 (5155), (746-7). [16 refs.]
Reports the successful use of irradiated mentor pollen and the successful use in inducing haploid parthenogenesis in P. trichocarpa.

Stettler, R. F. 1968. EXPERIMENTAL INDUCTION OF HAPLOID PARTHENOGENESIS IN POPULUS TRICHOCARPA. Genetics [Princeton?] 60 (1, pt. 2), (229). [From abstr. in Plant Breed. Abstr. 39 (3), (No. 5638).]
Haploid embryos and seedlings were obtained from some ♀s, but not from others. Chimaeras with haploid and diploid cells were also found.

Stettler, R. F., Bawa, K. S., and Livingston, G. K. 1969. HAPLOIDY: AN APPROACH TO THE DEVELOPMENT OF HIGH-YIELDING VARIETIES. [Pap.] 2nd FAO/IUFRO World Consult. For. Tree Breed., Washington No. FO-FTB-69-8/17, pp. [7]. [13 refs. [E.e.].]

Western Forest Genetics Assoc. 1966. SUBMITTED PAPERS, GENETICS. Proc. West. For. Genet. Ass., Olympia, Wash. 1965, (35-66). [Many refs.]

Western Forest Genetics Assoc. 1967. [ABSTRACTS OF PAPERS ON GENETICS, SUBMITTED AT THE ANNUAL MEETING, MOSCOW, IDAHO 1967.] Western Forest Genetics Association, Portland, Ore. pp. 6.

165.4

Stettler, R. F., and Bawa, K. S. 1971. EXPERIMENTAL INDUCTION OF HAPLOID PARTHENOGENESIS IN BLACK COTTONWOOD [POPULUS TRICHOCARPA T. & G. EX HOOK.]. Silvae Genet. 20 (1/2), (15-25). [E., 32 ref.]

17 SYSTEMATIC BOTANY

Broekhuizen, J. T. M. van. 1970. [MORPHOLOGICAL DESCRIPTION OF ONE-YEAR PLANTS OF POPULUS TRICHOCARPA 'FRITZI PAULEY'.] Ned. Bosb. Tijdschr. 42 (1), (1-4). [Du.e., 5 refs.]
Describes the leaf, shoot, form, branching habit, time of flushing, and illustrates the leaf vein pattern.

18 PLANT ECOLOGY

Anonymous. 1970. URTEILSGRUNDLAGEN FUR DIE TRICHOCARPA-PAPPEL. Forstpflanzen-Forstsamen, Strassenhaus/Neuwied 10, 2, 6-12, 41-42, Abb.

Beals, E. W. 1966. VEGETATION OF COTTONWOOD FORESTS ON KODIAK ISLAND. Canad. Fld. Nat. 80 (3), (166-71). [9 refs. B.A.P.]
Wetter sites had generally fewer trees, more shrubs and greater species diversity than the drier ones.

Muller, R. 1970. URTEILSGRUNDLAGEN FUR DIE TRICHOCARPA-PAPPEL. 4. NATURLICHE VERBREITUNG, KLIMA UND BODEN; FOLGERUNGEN FUR MITTELEUROPA. Forstpflanzen-Forstsamen, Strassenhaus/Neuwied 10, 3, 5-14 + 23-25, 3 Tab., 2 Ktn., 28 Lit. Ang., engl. Zsfg. (Hohen- und Klimastandorte, Westkuste Nordamerikas, Folgerungen fur den Anbau in Europa)

Pourtet, J. 1969. [POPULUS TRICHOCARPA TORR. ET GRAY – SOME SILVICULTURAL, PATHOLOGICAL AND TECHNOLOGICAL CHARACTERISTICS OF CLONE S.P. 126, RECENTLY INTRODUCED IN FRANCE.] Rev. for. franc. 21 (1), (41-8). [4 refs. [F.].]
This ♀ clone has been shown to be of good form, easy to propagate, quick growing, tolerant of a fairly wide range of site conditions, and resistant to the worst Poplar diseases.

Sivak, B., and Pearson, C. O. 1973. THE BACTERIAL AND FUNGAL FLORA OF THE BARK, WOOD, AND PITH OF ALDER, BLACK COTTONWOOD, MAPLE AND WILLOW. Canadian Journal of Botany 51 (10) 1985-1988 + 3 pl. [E.f., 13 ref. ORS]
Fungal and bacterial symbionts were found to be confined to the outer bark surfaces, where their occurrence was related to the surface structure. Inner bark, wood and pith were virtually aseptic.

2 SILVICULTURE

Langhammer, A. 1969. THE POPLAR IN NURSERY AND FIELD. Tidsskr Skogbruk 77 (2): 297-309 [Nor.]

23 REGENERATION AND FORMATION OF STANDS

231 NATURAL REGENERATION

DeBell, D. S., and Alford, L. 1972. SPROUTING CHARACTERISTICS AND CUTTING PRACTICES EVALUATED FOR COTTONWOOD. Tree Planters' Notes 23 (4) 1-3 [E., 3 ref.]
It is concluded that for management on short (2 to 3-year) rotations for pulpwood, P. trichocarpa should be felled in the dormant period.

232 ARTIFICIAL REGENERATION

232.1

Muller, R. 1969. URTEILSGRUNDLAGEN FUR DIE TRICHOCARPA-PAPPEL. Forstpflanzen-Forstsamen, Strassenhaus/Neuwied 4, 4, 14-23. 3 Abb., 36 Lit. Ang.

232.11

Ahlback, A. 1974. [THE WESTERNMOST OUTPOSTS OF SCANDINAVIAN FORESTRY [A STUDY TOUR TO THE FAROE ISLANDS, GREENLAND AND ICELAND].] Skogsagaren 50 (5) 23-30 [Sv.]
Includes: natural tree growth, planting activities, existing plantations, costs, suitable species, policies, etc.

Bjarnason, H. 1965. [GROWING CONDITIONS AND FORESTRY.] Extr. from Arsr. Skograktarf. Islands (5-12). 4 refs. [Ice.]
Includes a discussion of factors affecting the introduction of exotics into Iceland at various times since 1899.

Holubcik, M. 1969. [BROADLEAVED TREES AND SHRUBS IN THE FOREST RESEARCH INSTITUTE ARBORETUM, KYSIBYBEL, NEAR BANSKA STIAVNICA.] Lesn. Stud. Vyskum. Ust. Lesn. Hosp., Zvolen No. 3, pp. 137. [Slovak.e.ru.g., 37 refs.]
A very detailed evaluation of the performance of 164 species planted in this Slovakian arboretum. P. Trichocarpa can be considered for commercial forestry.

232.12

Joachim, H.-F., and Lattke, H. 1969. [CORRELATIONS BETWEEN LENGTH OF VEGETATIVE PERIOD AND HEIGHT GROWTH IN TREE WILLOW AND POPLAR CLONES.] Arch. Forstw. 18 (9/10), (957-61). [G., 5 refs.]
In a trial of 63 European clones of the Salix alba/S. fragilis group the Rumanian provenances were outstanding. With a trial of 51 P. trichocarpa clones little or no frost damage was observed.

Wolterson, J. F. 1973. [PROVENANCE RESEARCH ON POPULUS TRICHOCARPA IN 1972.] Nederlands Bosbouw Tijdschrift 45 (6) 209-211 [Nl.e.]

232.13

Borset, O., and Langhammer, A. 1967. [A TRIAL PLANTING OF POPULUS TRICHOCARPA IN AS.] Medd. Norske Skogforsoksv. 23 (No. 85), (41-65). [22 refs. [Nor.nor.g.g.].]
Gives figures showing growth, wood density, and information on frost resistance, canker, stem form, etc. of 21 clones. The two best clones at 12 years were from British Columbia.

Guldemond, J. L. 1966. [THE BALSAM POPLAR HYBRIDS POPULUS 'ANDROSCOGGIN', P. 'GENEVA' and P. 'OXFORD'.] Ned. Bosb. Tijdschr. 38 (9), (323-30). [5 refs. [Du.du.e.] 3 photos. 2 tbls.]

Werner, H. 1966. [EXPERIENCE WITH BALSAM POPLAR HYBRIDS AND BALSAM POPLARS IN HILLY AND LOW-MOUNTAIN COUNTRY.] Holzzucht, Reinbek 20 (3/4), (20-5). [10 refs. G.]
Trials at age $\geq$ 15 largely confirm the superiority of the Balsam hybrids 'Oxford' and 'Rochester' over the commercial Black Poplar hybrids on less suitable, and particularly on higher, sites (where only they and P. trichocarpa are promising, if slow). On good Poplar sites, their initial height superiority tends to disappear.

232.31

Koster, R. 1974. REPORT ON SEED COLLECTING OF POPULUS TRICHOCARPA IN 1972 AND 1973. Forestry and Forest Products Division. For. Occas. Pap. Food Agric. Organ. U. N. 1: 38-39.

232.315

Trappe, J. M. 1964. POPULUS TRICHOCARPA SEEDS ENDURE ADVERSITIES. Tree Plant. Notes No. 65, (31), 1 ref.

232.328

Bowersox, T. W. 1970. INFLUENCE OF CUTTING SIZE ON JUVENILE GROWTH AND SURVIVAL OF HYBRID POPLAR CLONE NE-388 [POPULUS MAXIMOWICZII X P. TRICHOCARPA]. Tree Plant. Notes 21 (4), (1-3). [8 refs.]

232.411

Muller, R. 1972. URTEILSGRUNDLAGEN FUR DIE TRICHOCARPA-PAPPEL. 8. DIE PAPPELANERKENNUNG GRUNDE UND HANDHABUNG. Forstpflanzen-Forstsamen, Strassenhaus/Neuwied 12, 1, 5-11, 24-30, Lit. Ang. engl. Zsfg.

232.43

Decourt, N., and Lemoine, M. 1974. [FIRST RESULTS OF A CLINAL SPACING EXPERIMENT WITH POPULUS TRICHOCARPA.] Annales des Sciences Forestieres 31 (3), (171-179) [F.e.de., 5 ref.]
Describes the use of a 'clinal' lay-out to determine the effects of a progressive increase in spacing, from 1.0 to 5.96 m, on height and diameter growth during the first few years in a plantation of P. trichocarpa.

238 TIMBER PLANTATION CROPS REQUIRING SPECIAL TREATMENT

Denev, D. A. 1974. [GROWTH AND YIELD OF FERTILIZED AND IRRIGATED POPLAR PLANTATIONS.] Gorskostopanska Nauka 11 (5) 53-62 [Bulg.ru.de., 12 ref.]
Describes studies on the effects of NPK fertilizers and irrigation in a stand of Populus 'Vernirubens' established on a drained site 3.3 m above the mean level of the Danube in Bulgaria. Fertilizing without irrigation had little effect on growth. NPK fertilizers plus irrigation had the best effect, but as NPK was only slightly superior to NP, the use of NP plus irrigation in the second half of the growing season is recommended.

Heilman, P. E., Peabody, D. V., Jr., DeBell, D. S., and Strand, R. F. 1972. A TEST OF CLOSE-SPACED, SHORT-ROTATION CULTURE OF BLACK COTTONWOOD. Canadian Journal of Forest Research 2 (4) 456-459 [E.f., 7 ref.]
Gives results of a study of the effect of fertilizing and spacing on the yield of P. trichocarpa in two successive 2-year rotations in Washington. Yield in the first rotation was affected by spacing and fertilizing, being greatest with the closest spacing, whereas in the second rotation the yield was not significantly affected by spacing.

Muller, R., and Sauer, E. 1972. [AN ASSESSMENT OF POPULUS TRICHOCARPA, INCLUDING ALSO AN ASSESSMENT OF POPLAR GROWING TO DATE.] Urteilsgrundlagen fur die trichocarpa-Pappel. Versuch einer Analyse auch der bisherigen Pappelwirtschaft. German Federal Republic, Wirtschafts- und Forstverlag Euting, K.G., Strassenhaus. 150 pp. [De.e.f., Many ref. FCAH]
The book is a reissue of articles which first appeared in Forstpflanzen-Forstsamen, 1969-1972.

Sauer, E., and Muller, R. 1971. URTEILSGRUNDLAGEN FUR DIE TRICHOCARPA-PAPPEL. ABSCHNITT 6. EVOLUTIONSPROBLEME UND NORDVERSCHIEBUNG, 2. TEIL. Forstpflanzen-Forstsamen, Strassenhaus/Neuwied 11, 3, 111-118, 1 Abb., 1 Tab., 25 Lit. Ang., dt. u. engl. Zsfg.

Sauer, E., and Muller, R. 1971. URTEILSGRUNDLAGEN FUR DIE TRICHOCARPA-PAPPEL. 7. UBERBLICK, SCHLUSSE, PROBLEM. Forstpflanzen-Forstsamen, Strassenhaus/Neuwied 11 (1971), 4, 140-142.

4 FOREST INJURIES AND PROTECTION

42 INJURIES FROM INORGANIC AGENCIES (EXCLUDING FIRE)

422 TEMPERATURE INFLUENCES. INSOLATION

Ragnarsson, H. 1964. [DAMAGE TO TREES IN SPRING 1963.] Extr. from Arsr. Skograktarf. Islands (25-7). [Ice.]
Discusses damage in Iceland by a severe frost in early April after a long cold spell. Species badly affected include Populus trichocarpa, Picea engelmannii, P. glauca, P. pungens, Abies lasiocarpa, Willows and Sitka Spruce.

425 CHEMICAL INFLUENCES (ATMOSPHERIC)

Iarger, J. R. E. 1973. DAMAGE TO VEGETATION BY 'HLORINE GAS. International Journal for Environmental Studies , 93-108 [E.] From Berichte Biochemie und Biologie (1974) 403, 939. De. Reinbek.
'he effects of chlorine gas to foliage were tested.

429 MISCELLANEOUS

Krejcberg, Z. N., et al. 1969. [EFFECT OF GAMMA RADIATION)N THE WOOD AND LIGNIN OF GROWING POPLAR.] In limija drevesiny 4. Izdatel'stvo 'Zinatne', Riga. pp. 101-7. [Ru., 16 efs. P.R.]
'uttings of P. trichocarpa were irradiated with 200, 500 and 5000 r, nd rooted. Examination of 1-year shoots showed that a depressing ose of γ-radiation (5000 r) caused increased accumulation of xtractives and soluble lignin in the new shoots, and retarded ynthesis of cellulose and total lignin. In shoots of irradiated uttings, the low-molecular part of the lignin is less methoxylated han that of normal shoots; the high-molecular part of the lignin is nchanged.

)re, V. N., Krejcberg, Z. N., and Sergeeva, V. N. 1969. [DEVELOP-IENT OF POPLAR PLANTS GROWN FROM GAMMA-RRADIATED CUTTINGS.] In Himija drevesiny 4. Izdatel'stvo Zinatne', Riga. pp. 97-100. [Ru., 7 refs. P.R.]
'uttings of P. trichocarpa were irradiated with doses of 500, 1000 nd 5000 r at 10 r/sec. Irradiation with 500 r stimulated shoot rowth, but 5000 r depressed shoot growth and development.

)re, V. N., Krejcberg, Z. N., and Sergeeva, V. N. 1969. [EFFECT)F NEUTRON IRRADIATION OF CUTTINGS ON THE)EVELOPMENT OF POPLAR SHOOTS.] In Himija drevesiny 4. zdatel'stvo 'Zinatne', Riga. pp. 93-6. [Ru., 9 refs. P.R.]
'uttings of P. trichocarpa were irradiated (fast neutrons) with doses of 50, 100, 500 and 1000 rd [rutherfords] at 1 krd/hour. The 500 d dose depressed the growth of new shoots and induced certain norphological changes. The 1000-rd dose significantly depressed the rowth and development of new shoots.

Sergeeva, V. N., Kreitsberg, Z. N., and Ore, V. N. 1973. [RECOVERY OF NORMAL PHYSIOLOGICAL ACTIVITY IN SHOOTS OF POPULUS TRICHOCARPA AFTER GAMMA-IRRADIATION.] Khimiya Drevesiny No. 14, 44-46 [Ru., 9 ref. PR]
Describes observations on cuttings of Poplar given a depressing dose of radiation, viz. 5000 r. This dose depressed the growth of new shoots and caused various morphological anomalies. Growth anomalies such as forking shoots, sprouting of underground buds, and asymmetrical leaves, occurred in the first but not in the second growing season after the radiation treatment.

43 FOREST FIRES

Philpot, C. W. 1971. THE PYROLYTIC EFFECT OF TREATING COTTONWOOD WITH PLANT ASH. US For. Serv. Res. Pap. Intermt. For. Range Exp. Sta. No. INT-139, pp. 5. [6 ref.]
Ash lowered the initiation temperature of the cellulose and decreased the intensity of the endotherm; the Poplar ash appeared to be more effective than that of the Pine.

44 DAMAGE BY HARMFUL PLANTS. VIRUS DISEASES

Bier, J. E. 1965. SOME EFFECTS OF FOLIAGE SAPROPHYTES IN THE CONTROL OF MELAMPSORA LEAF RUST OF BLACK COTTONWOOD. For. Chron. 41 (3), (306-13). 6 refs.
The saprophytic microflora associated with healthy foliage of P. trichocarpa included micro-organisms capable of inhibiting the germination of, and infection by, the uredospores of M. occidentalis. When the saprophytes were removed from healthy foliage, heavy infection by M. occidentalis resulted.

Iakovleva, L. M. 1972. NEW BACTERIOSIS OF POPULUS TRICHOCARPA. Bacillus. Mikrobiol Zhur 34 (1): 110-111. [UKR]

Lane, W. D., and Shaw, M. 1974. ISOLATION AND AXENIC CULTURE OF POPLAR RUST. Canadian Journal of Botany 52 (10) 2228-2229 + 1 pl. [E.f., 5 ref. ORS]
Describes the establishment of axenic colonies of Melampsora occidentalis from uredial infections of leaves of P. trichocarpa placed on a defined, agar-based medium.

5 FOREST MENSURATION

52 MEASUREMENTS OF STEM DIMENSIONS AND VOLUME OF TREES, STANDS, FORESTS AND TIMBER

Smith, J. H. G., and Kozak, A. 1967. THICKNESS AND PERCENTAGE OF BARK OF THE COMMERCIAL TREES OF BRITISH COLUMBIA. Faculty of Forestry, University of British Columbia, Vancouver. pp. 33. [41 refs.]

8 FOREST PRODUCTS AND THEIR UTILIZATION

81 WOOD AND BARK: STRUCTURE AND PROPERTIES

810 GENERAL INFORMATION ON WOODS

Anonymous. 1971. [STUDY OF THE WOOD OF POPULUS 'RICHOCARPA 'SP 126'.] Centre Technique du Bois, Paris. pp. 4. [F., 1 ref. PR]
Analyses the anatomical, chemical, physical, mechanical and working properties of the wood of three sample trees. It constitutes a valuable source of wood for peeling for veneer, but is less promising as a source of sawtimber (particularly) or pulpwood.

811 STRUCTURE. IDENTIFICATION

Anonymous. 1964. [STRUCTURE OF IMPORTED WOODS. (NOS. 51-60).] Bull. For. Exp. Sta., Meguro, Tokyo No. 171, (135-54). 9 refs. [Jap.]

811.1

Isebrands, J. G., and Parham, R. A. 1974. TENSION WOOD ANATOMY OF SHORT-ROTATION POPULUS SPP. BEFORE AND AFTER KRAFT PULPING. Wood Science 6 (3) 256-265 [E., 43 ref.]
Six trees of Populus 'Tristis No. 1' grown at a spacing of 1 X 1 ft (in the north-central USA) were harvested at the end of either the second or the third growing season.

811.2

Isebrands, J. G., and Parham, R. A. 1974. SLIP PLANES AND MINUTE COMPRESSION FAILURES IN KRAFT PULP FROM POPULUS TENSION WOOD. IAWA Bulletin 1, 16-21 + 2 pl. [E., 13 ref.]

812 PHYSICAL AND MECHANICAL PROPERTIES

Bloomberg, W. J., and Farrell, D. 1965. MEASUREMENT OF WOOD MOISTURE CONTENT USING THE COLMAN ELECTRODE. For. Chron. 41 (3), (352-63). 6 refs.
When the electrodes were inserted into living P. trichocarpa trees, a fairly good correlation with soil m.c. resulted, when the trees were subjected to cycles of drought and watering.

812.3

Lin, S. Y. 1972. THE RELATIONSHIP BETWEEN WOOD DENSITY AND POROSITY AND FIBER DIMENSIONS IN POPULUS TRICHOCARPA T. & G. Mokuzai Gakkaishi (Journal of the Japan Wood Research Society) 18 (10): 485-488 [E.jap., 10 ref. PR]
Wood density decreased curvilinearly with increasing ring number from the pith.

Maeglin, R. R., and Wahlgren, H. E. 1972. WESTERN WOOD DENSITY SURVEY. REPORT NO. 2. USDA Forest Service Research Paper, Forest Products Laboratory, Madison No. FPL-183, 24 pp. [E., 24 ref.]

Okkonen, E. A., Wahlgren, H. E., and Maeglin, R. R. 1972. RELATIONSHIPS OF SPECIFIC GRAVITY TO TREE HEIGHT IN COMMERCIALLY IMPORTANT SPECIES. Forest Products Journal 22 (7) 37-42 [E., 15 ref.]
Sp.gr. increased with increasing height in species having a low late-wood % (Abies balsamea, Picea engelmannii, Thuja plicata, and especially P. trichocarpa); no clear trend was apparent in the other Picea spp.

813 WOOD CHEMISTRY

813.1

Saleh, T. M., Leney, L., and Sarkanen, K. V. 1967. RADIOAUTOGRAPHIC STUDIES OF COTTONWOOD, DOUGLAS-FIR AND WHEAT PLANTS. Holzforschung, Berlin 21 (4), (116-20). [16 refs. [E.e.g.] P.R.]
In radioautographs of microtome sections taken from 1-year P. trichocarpa 4 weeks after immersion in tritiated ferulic acid (t.f.a.), radioactive lignin appeared first in the primary wall at the cell corners, and then along the middle lamella, proceeding first along radial walls.

Shafizadeh, F., and McGinnis, G. D. 1971. CHEMICAL COMPOSITION AND THERMAL ANALYSIS OF COTTONWOOD. Carbohyd. Res. 16 (2), (273-7). [16 refs. ORS]
Tabulated results of analyses of P. trichocarpa heartwood show a lignin content of 31·9% and a polysaccharide content of 76·1% (44·1% cellulose, 20·8% 4-O-methylglucuronoxylan and 9·7% glucomannan).

813.4

Philpot, C. W. 1971. THE PYROLYSIS PRODUCTS AND THERMAL CHARACTERISTICS OF COTTONWOOD AND ITS COMPONENTS. USDA Forest Service Research Paper, INT-107, 31 p. Intermountain Forest and Range Experiment Station. [E., 26 ref.]
Gives details of the thermogravimetric analysis and differential thermal analysis of Populus trichocarpa wood and two of its components (cellulose and xylan) and describes the pyrolysis products separated by gas/liquid chromatography.

83 TIMBER MANUFACTURING INDUSTRIES AND PRODUCTS

Heebink, T. B. 1965. SUITABILITY OF SEVEN WEST COAST SPECIES FOR PALLETS. U.S. For. Serv. Reg. Pap. FPL-22, 16 p. U.S. For. Prod. Lab., Madison, Wisc.

86 PULP INDUSTRIES

Wayman, M., Anderson, C. B., and Rapson, W. H. 1965. PERACETIC ACID BLEACHING OF GROUNDWOOD FROM NINE CANADIAN WOOD SPECIES. Tappi 48 (2), (113-20). 11 refs.
Promising results have been obtained with 6 Canadian hardwoods and 3 softwoods, the best with P. trichocarpa and the poorest with Alnus rubra.

89 OTHER FOREST PRODUCTS

Estes, T. K., and Pearl, I. A. 1967. STUDIES ON THE BARKS OF THE FAMILY SALICACEAE. XIII. HOT-WATER EXTRACTIVES OF THE GREEN BARK OF POPULUS TRICHOCARPA. Tappi 50 (7), (318-24). [21 refs.]
The hot-water extractives were fractionally extracted with $CHCl_3$, ether, and Et acetate. Major crystalline components found were salicin, trichocarpin, salireposide, salicyl alcohol, pyrocatechol, p-coumaric acid, and a new glucoside, trichocarposide.

Estes, T. K. 1967. A STUDY OF THE GLYCOSIDES IN THE HOT WATER EXTRACT OF THE GREEN BARK OF POPULUS TRICHOCARPA. Abstr. of thesis, in Dissert. Abstr. 28B (2), (575) [O.R.S.]

Pearl, I. A., and Darling, S. F. 1968. STUDIES ON THE BARKS OF THE FAMILY SALICACEAE. XVI. THE STRUCTURE OF SALIREPOSIDE. XVII. TRICHOSIDE, A NEW GLUCOSIDE FROM THE BARK OF POPULUS TRICHOCARPA. Phytochemistry, Oxf. 7 (5), (821-9). [11 refs. O.R.S.]
A new formula for salireposide is proposed. Trichoside, previously found but not identified in the green bark of P. trichocarpa, was isolated in substantial quantities from the furrowed brown bark, the major phenolic glucosides of which were trichocarpin and salireposide.

Pearl, I. A., and Darling, S. F. 1968. STUDIES ON THE BARKS OF THE FAMILY SALICACEAE XVIII. STUDIES ON THE HOT WATER EXTRACTIVES OF THE BROWN BARK OF POPULUS TRICHOCARPA. Tappi 51 (11), (537-9). [13 refs.]
Fractional extraction with ethyl acetate yielded salicin, trichocarpin, salireposide, salicyl alcohol and pyrocatechol, together with smaller amounts of 3 compounds not previously reported from the bark of any species of the Salicaceae: trichoside, 2,6-dimethoxybenzoquinone and cinnamic acid.

Pearl, I. A., and Larson, K. 1965. STUDIES ON THE HOT WATER EXTRACTIVES OF THE BROWN BARK OF POPULUS TRICHOCARPA. Tappi 48 (12), (714-6). 9 refs.

9 FORESTS AND FORESTRY

FROM THE NATIONAL AND INTERNATIONAL POINTS OF VIEW

Metcalf, M. E. 1965 HARDWOOD TIMBER RESOURCES OF THE DOUGLAS-FIR SUBREGION. U.S. For. Serv. Resource Bull. Pacif. Nthwest. For. Range Exp. Sta. PNW-11, pp. 12.
Gives statistics, adjusted for 1963, from inventories of Alnus rubra, Acer macrophyllum, and Populus trichocarpa, with some data on other hardwoods.

MISCELLANEOUS

Babos, I. 1973. A NEMESNYARAK, ELSOSORBAN AZ ORIASNYAR TERMOHELYI IGENYE AZ ALFOLD HOMOK ALAPKOZETU ERDOGAZDASAGI TAJAIBAN. Erdeszeti Kutatasok, Budapest, 69. 1: 201-215.

Babos, I. 1974. UJ UTAK A NYARGAZDALKODASBAN: A TRICHOCARPA-NYARAK JELENTOSEGE. Az Erdo, Budapest 23, 2: 68-93. old. folytatas.

Babos, I., Jaro, Z., and Keresztesi, B. 1964. NYARFATERMESZTES A "JELEN" VAD- ES ERDOGAZDASAGBAN. Az Erdo, Budapest, 13. 11: 495-505.

Bajdo, E. 1974. A HOMOKI AKAC-NYAR ELEGYITESEK KERDESEROL. In "Jubileumi tudomanyos ulesszak, Pusztakladany, 1974. szeptember 26." 46-50.

Beky, A., Gergacz, J., Halupa, L., and Kovacs, F. 1974. A HANSAGI NYARASOKBAN VEGZETT GYOMIRTASI KISERLETEK UJABB EREDMENYEI. Erdeszeti Kutatasok, Budapest, 69. 1: 263-274.

Csizmadia, P-ne. 1969. A CSER, AKAC ES NYARFELEK IPARI FELDOLGOZASANAK JELENLEGI HELYZETE ES TOVABBI LEHETOSEGEI. Faipari Kutatasok, Budapest, 1: 67-74.

Fillo, Z., and Babos, K. 1969. A CSER, AKAC ES NYARFELEK ANATOMIAI TULAJDONSAGAI. Erdeszeti Kutatasok, Budapest, 1: 87-102.

Gergacz, J. 1974. REZISZTENCIARA NEMESITES EREDMENYEI A NYAR KLONKISERLETEKBEN. Az Erdo, Budapest, 23. 12: 557-559.

Gergacz, J., Halupa, L., and Szontagh, P. 1968. NYARKEREGMEGBETEGEDESEK. 1967-ben, Az Erdo, Budapest, 17. 5: 222-226.

Gyarmatine, Proszt S. 1969. A JO MINOSEGU NYARSZAPORITOANYAGTERMELES TERMOHELYI FELTETELEI. Erdeszeti Kutatasok, Budapest, 65. 2-3: 111-114.

Gyarmatine, Proszt S. 1973. A MUTRAGYAZAS VIZSZENNYEZO HATASANAK VIZSGALATA FENYO- ES NYARERDOKBEN. In "Erdeszeti Kornyezetvedelmi Tudomanyos Ertekezlet, Budapest, 1973. aprilis 18" 88-93.

Hadnagy, J. 1969. A CSER, AZ AKAC ES A NYARFELEK FIZIKOMECHANIKAI TULAJDONSAGAI. Faipari Kutatasok, Budapest, 1: 75-85.

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A partially annotated list developed partly from abstracts furnished by the Commonwealth Forestry Bureau and arranged according to The Oxford System of Decimal Classification for Forestry.

Additional keywords: Silviculture, biology, diseases, insects, utilization.

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Gas Exchange Of Detached Needles Of Southern Pines And Certain Hybrids

Robert M. Allen

Southern Forest Experiment Station
Forest Service
U.S. Department of Agriculture
1976

GAS EXCHANGE OF DETACHED NEEDLES OF SOUTHERN PINES AND CERTAIN HYBRIDS

Robert M. Allen[1]

Oxygen production and stomatal characteristics of detached needles of the major southern pines and certain species hybrids were measured to evaluate species differences in responsiveness to environmental change. Regardless of species, oxygen production rates were high during the season of needle formation, gradually declined during the first winter, peaked again in the second summer, and decreased thereafter. Longleaf and slash pine rates decreased more than loblolly and shortleaf rates following exposure to darkness and were also more sensitive to changes in temperature. Such differences were generally larger in summer than in winter. Seasonal patterns of and species differences in stomatal activity generally paralleled those for oxygen production. Longleaf and slash stomates apparently closed faster and more completely in darkness than those of loblolly and shortleaf. Reactions of species hybrids generally were similar to those of the male parent species.

Additional keywords: *Pinus palustris, P. elliottii, P. taeda, P. echinata,* stomatal response.

Because forest trees are subject to a widely varying environment, the physiological efficiency with which they adapt to changing conditions may be more important to growth than their performance under optimum conditions. Certainly, trees that efficiently adapt to fluctuations in weather should grow more than those that do not. Photosynthetic plasticity has been suggested by Mooney and others (1964) as one way in which plants adjust to seasonal changes in environment.

The rate of photosynthesis in tree species is highly variable because a number of internal and external factors affect it (Kramer and Kozlowski 1960). Rate of gas exchange is an integration of many of these factors and thus may be a reasonable index of the physiological state of the tree. Response in rate of gas exchange to environmental change, therefore, may be a measure of the tree's ability to physiologically adjust to environmental change.

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In the present study, the rates of oxygen production of freshly detached needles of four species of southern pines and certain species hybrids were measured during a series of changes in light and temperature to determine if the species differ in their ability to respond to environmental change. Eventually such differences could be exploited in selection and breeding.

Materials and Methods

Needles were collected from 15 trees of each species growing in a 3-year-old plantation in Gulfport, Mississippi. The longleaf (*Pinus palustris* Mill.) and shortleaf (*P. echinata* Mill.) saplings were from bulk seedlots; the slash (*P. elliottii* Engelm.) and loblolly (*P. taeda* L.) saplings were wind-pollinated progeny of two putative superior trees. Needles were selected at random from the main flush of terminal growth, but those that were damaged mechanically or by insects were rejected. Needles from the 1964 spring flush were collected and analyzed from September 1964 through August 1965; those from the 1965 spring flush were tested from June through October 1965. Generally, two or three collections were made each month.

Gas exchange was measured in a Bronwill UVL Warburg apparatus.[2] The outside well of the 13 ml flask contained 3 ml of 0.6 percent (at 38° C) Paradee's CO_2 buffer (as given by Umbreit *et al.* 1957); the center well contained 0.5 ml of distilled water.

The 2.5 cm distal tips of five needles (one from each of five trees of a given species) were placed in the center well in an upright position. Surface tension of the water caused them to adhere to the wall of the well.

In a typical experiment the needle bundles were collected from the trees at 8:00 a.m., placed in test tubes containing enough water to cover the basal ends of the needles, and brought into the laboratory. Tips were removed from each needle and placed in the prepared Warburg flask by 8:45 a.m. Flasks were then put in the Warburg bath preset at 30° C. All experiments were made at 1,500 fc measured with a GE 213 meter at the bottom of the flasks. After 10 minutes, the manometers were closed and measurements started. Three 30-minute O_2 uptake measurements were made with the lights on, then the lights were extinguished and a 60-minute measurement of O_2 uptake was made after which the lights were turned on and two more 30-minute O_2 production measurements taken. Bath temperature was then increased to 40° C, and three more 30-minute O_2 production determinations were made. All measurements started from an open stopcock with 5-minute intervals between measurements. The time for CO_2

[2] Mention of trade names is solely to identify equipment used and does not imply endorsement by the U.S. Department of Agriculture.

pressure to come into equilibrium was disregarded because differences among species were of primary concern rather than absolute values. Net rates of 0_2 production, uncorrected for 0_2 uptake, are presented in this paper.

For the hybrid experiments, needles came from trees in 2- to 8-year-old plantings (table 1) in or near Gulfport. Collections began in spring 1965 and continued through spring 1966. Procedures for sampling needles and determining 0_2 production were the same as described above. But the schedule of measurements was different because the primary purpose was to measure the 0_2 production after a period of darkness. The successive measurements were 30-minute 0_2 production, 30-minute 0_2 uptake, 30-minute 0_2 production, 60-minute 0_2 uptake, and 30-minute 0_2 production—all at 30° C.

Table 1.—*Parentage of the hybrids and their controls*

Planting	Control	Control	Hybrid	Hybrid
A	El-1 x W[1]	Ec-b[2]	El-2 x Ec-1[3]	...
B	Ec-2 x W	El-3 x W	Ec-2 x El-3	...
C	El-b	Ec-b	El-2 x Ec-1	Ec-3 x El-4
D	El-b	T-b	El-5 x T-m[4]	El-6 x T-m
E	T-1 x W	El-7 x W	El-7 x T-1	...
F	El-8 x W	T-2 x W	El-8 x T-m	T-2 x El-8
G	T-b	P-b	P-s[5] x T-m	...
H	P-b	Ec-b	P-1 x Ec-4	...
I	El-b	Ec-b	Ec-5 x El-m[4]	El-9 x Ec-m[4]

[1] El-1 x W = wind-pollinated progeny of slash parent tree #1.
[2] Ec-b = progeny from shortleaf bulk seedlot.
[3] El-2 x Ec-1 = hybrid progeny between the female parent, slash pine tree #2, and male parent, shortleaf pine tree #1. Female parent always listed first.
[4] T-m, Ec-m, or El-m = bulk mixture of loblolly, shortleaf, or slash pine pollen.
[5] P-s = several longleaf pine female parents.

Stomatal closure was estimated by Fry and Walker's (1967) adaptation of Froeschel and Chapman's (1951) pressure-infiltration technique. A needle section was inserted into a clear plastic cuvette filled with 50-percent alcohol. Infiltration into the stomates was observed through a binocular microscope while air pressure inside the cuvette was gradually increased. The pressure at which 50 percent of the stomates were infiltrated was read from a gauge in the air line. Fry and Walker (1967) showed a strong linear correlation between infiltration pressure and transpiration in Douglas-fir. In the present study the diffusive capacity of the stomates was considered to be 100 percent when half of them were infiltrated at 3 lb/in^2 of pressure, and 0 percent when half were not infiltrated at 36 pounds. Pressures were transformed into percentages of apparent diffusive capacity by straight-line interpolation between the 0 and 100 percent points.

Samples for the infiltration tests were taken in the same way as for the manometric experiments, except that tips were cut from two needles per fascicle for duplicate samples. The needle sections, with their bases immersed in water at 30° C, were held in ordinary air and 1,500 fc of light for 45 minutes before pre-darkness measurements. The duplicate samples were given the same light exposure and then darkened for 1 hour before measurements were made.

Results and Discussion

The highest rate of 0_2 evolution was usually found in the initial 30° C reading; the next two measurements were progressively lower (fig. 1). The reason for the decline was not determined. There was not much difference among species when the first three readings were expressed as a percentage of the initial 0_2 measurement.

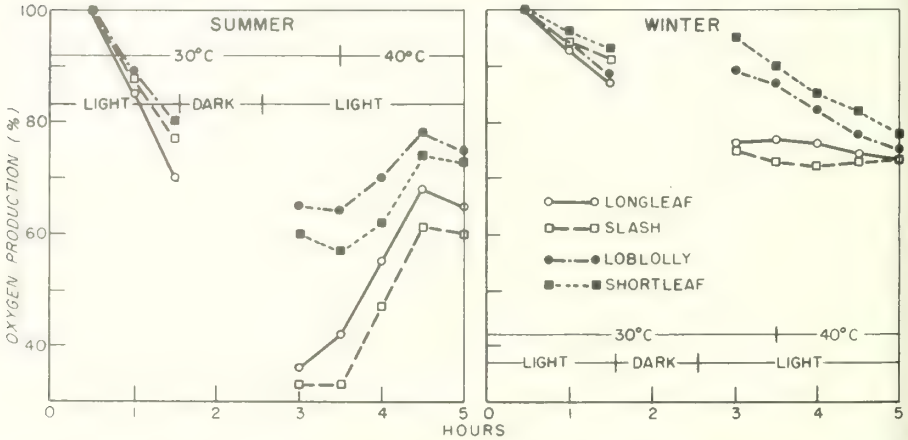

Figure 1.—*Average 0_2 production (as a percentage of initial observation) in response to environmental changes and time after needle detachment. Summer observations extend from June through early September; winter, from late November through January.*

Immediately after 1 hour of darkness (post-dark), longleaf and slash pine needles showed much greater reductions in 0_2 evolution than did either loblolly or shortleaf pine. The differences among species were generally greater in summer than in winter.

When the bath temperature was raised from 30° to 40° C, 0_2 production usually increased in summer and decreased in winter.

Seasonal Changes in Oxygen Production and Uptake

Rates were high during the first summer after needle emergence, then gradually dropped to a low during the winter. Oxygen production increased sharply the following spring, when the needles

were about 1 year old, then gradually decreased during the summer (fig. 2). All four species responded similarly to seasonal changes. The only marked departure was the rapid decrease in 0_2 production by shortleaf pine needles in their second summer. This decrease was associated with pronounced yellow mottling of needles.

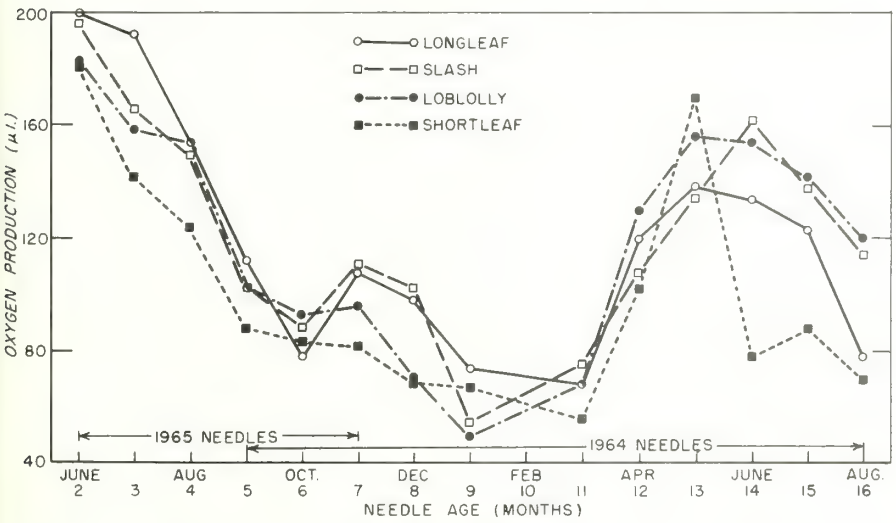

Figure 2.—*0_2 production of detached needles (μl 0_2/30 minutes/15 needle tips at 30° C) averaged over several experiments per month. Measurements were made from September 1964 through August 1965 on needles from the 1964 spring flush and from June through October 1965 on needles from the 1965 spring flush.*

Low rates of 0_2 production in October presumably were associated with droughts from late September through early November in both 1964 and 1965. Fall dry spells are typical in southern Mississippi. Rates for slash and longleaf pine needles increased slightly in November and December, after fall rains started and before cold weather occurred.

Winter rates of 0_2 production were at least a third of the maximum summer rates, confirming earlier reports (Huberman 1940) that winter photosynthesis contributes to the growth of southern pines.

As has been observed by McGregor and Kramer (1963), 0_2 uptake gradually increased from summer through fall to a maximum in late winter or early spring. It decreased markedly as the second summer progressed (fig. 3), presumably because of needle aging.

During the first summer, longleaf pine had a higher rate of 0_2 uptake than the other species, but by late fall and early winter the rates of all four were quite similar. From early spring through the second summer, the rates of 0_2 uptake for longleaf and slash pines

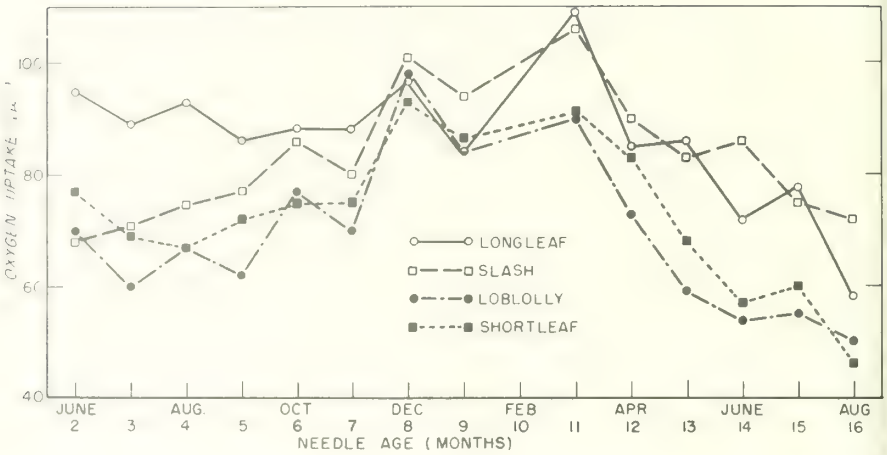

Figure 3.- *Average 0_2 uptake of detached needles by month (μl 0_2/hour/15 needle tips at 30° C).*

were generally similar and higher than those of loblolly and shortleaf pines.

Temperature Change

Differences between 0_2 production at 30 and 40° C varied among seasons and species (fig. 4). Differences were similar and smallest for all species in winter. Longleaf and slash pine, however, had much larger differences than loblolly and shortleaf pine during spring and summer. The change in net 0_2 production with increase in temperature may result from several factors—changes in stomatal opening, changes in membrane permeability, changes in respiration, heat stability of the photosynthetic mechanism, and an increase in CO_2 pressure in the flasks.

Dark Closure of Stomates

Species differences in pre- and post-dark 0_2 production (fig. 1) may be the result of a faster rate of stomatal closure in the slash and longleaf needles than in loblolly and shortleaf. Hodges (1967) found marked differences in rates of stomatal closure among four genera of conifers and also noted that short-term fluctuations in photosynthesis of *P. sylvestris* L. were related to the rapid opening and closing of its stomates.

In the present study, the amount of pre- and post-dark 0_2 production was related to the apparent diffusive capacity of the stomates as measured by the infiltration technique. In one experiment, the pre-dark 0_2 production rate of slash pine needles was 87 μl with the apparent diffusive capacity of the stomates at 80 percent; post-dark

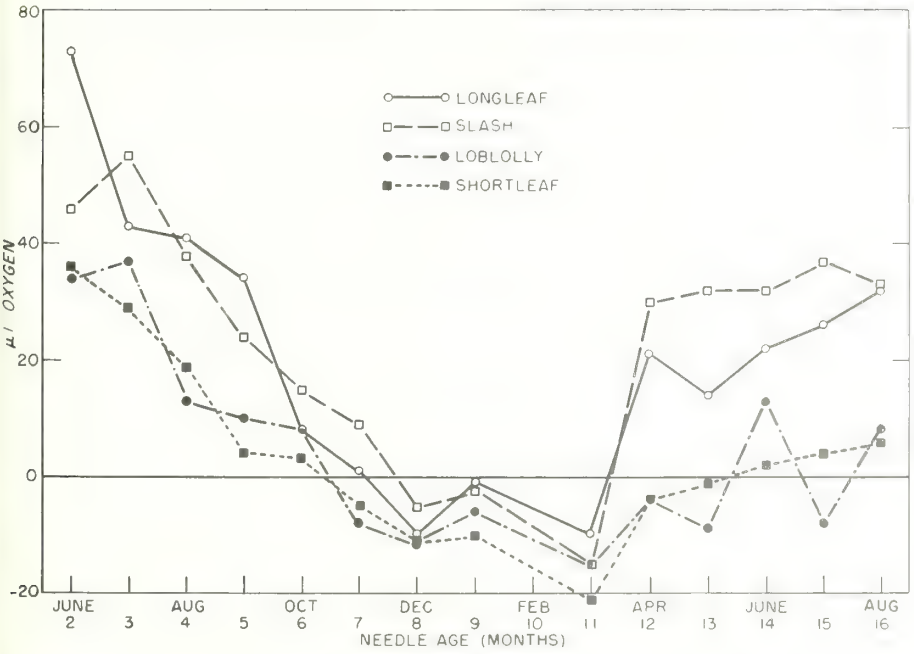

Figure 4.—*Average differences between the last measurements of 0_2 production at 30 and 40° C by month.*

0_2 production was 41 μl with the apparent diffusive capacity of 46 percent. For loblolly pine, pre-dark values were 93 μl at 88 percent, and post-dark 0_2 production was 80 μl at 81 percent. Similar correlations were obtained many times. Other researchers have observed good agreement between stomatal apparent diffusive capacity and gas exchange when stomatal openings varied in response to differing water regimens (Lopushinsky 1969, Miller and Allen 1971).

The seasonal pattern in reduction of 0_2 production after 1 hour of darkness (fig. 5) suggests that the stomates can close faster in spring and summer than in winter. Differences among the species were greatest in the summer. Greater post- than pre-dark 0_2 productions were obtained with loblolly and shortleaf pine needles on some dates in winter and early spring, but with longleaf and slash pine needles the pre-dark 0_2 production was always greater than post-dark.

Because of changing levels of photosynthesis, it is difficult to say how accurately these data reflect stomatal closure throughout the season. However, infiltration measurements on slash pine needles did show a slower dark closure during winter than during summer. Also, for a given species within a given season, the reduction attributable to the dark period was not correlated with the pre-dark 0_2 production. Thus, the seasonal pattern in figure 5 gives the qualitative if not the quantitative pattern of dark response of stomates.

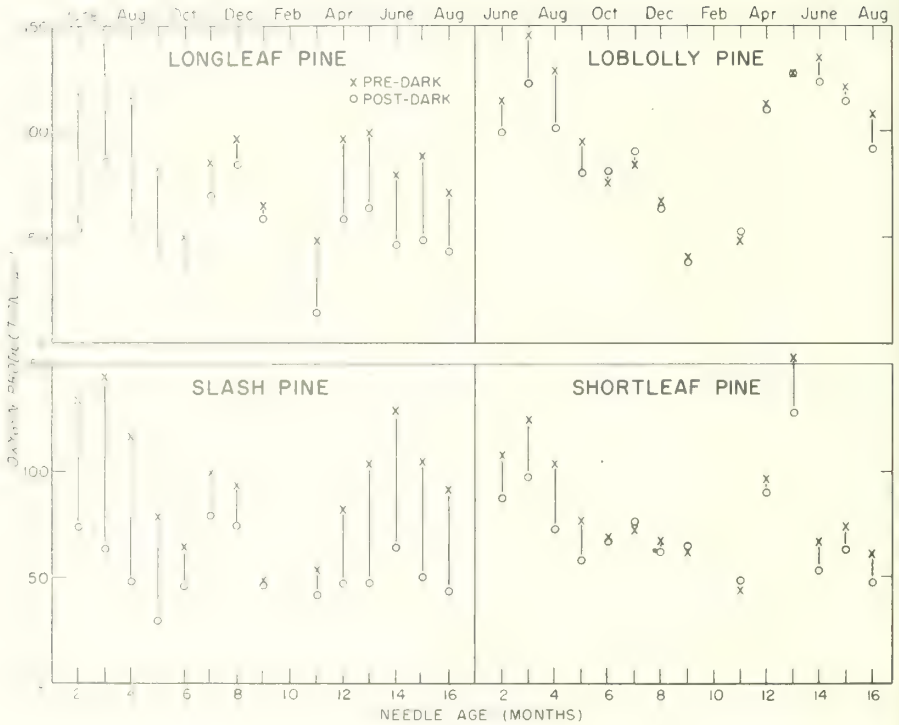

Figure 5.—*Average differences in pre- and post-dark O_2 production by month (μl O_2/30 minutes/15 needle tips at 30° C).*

Hybrid Responses

Responses of the hybrids between longleaf or slash and loblolly or shortleaf pines were quite similar to those of the male parent species whether measured by manometry (fig. 6) or by the infiltration technique (fig. 7). Only slash x loblolly hybrids deviated from this pattern: about 60 percent reacted like their loblolly pine parent; the rest were intermediate between the parent species. Measurements taken on different sampling dates sometimes showed the slash x loblolly hybrids reacting like the male parent (fig. 6, F; fig. 7, D_2), and sometimes their reaction was intermediate between parents (fig. 7, F_1; fig. 6, D_1). Variation among sampling dates and individual parent trees, therefore, may account for these few departures from the general trend.

Only two specimens of the rare longleaf x shortleaf hybrid were available; the limited data nevertheless support observations on the other hybrids (fig. 6, H).

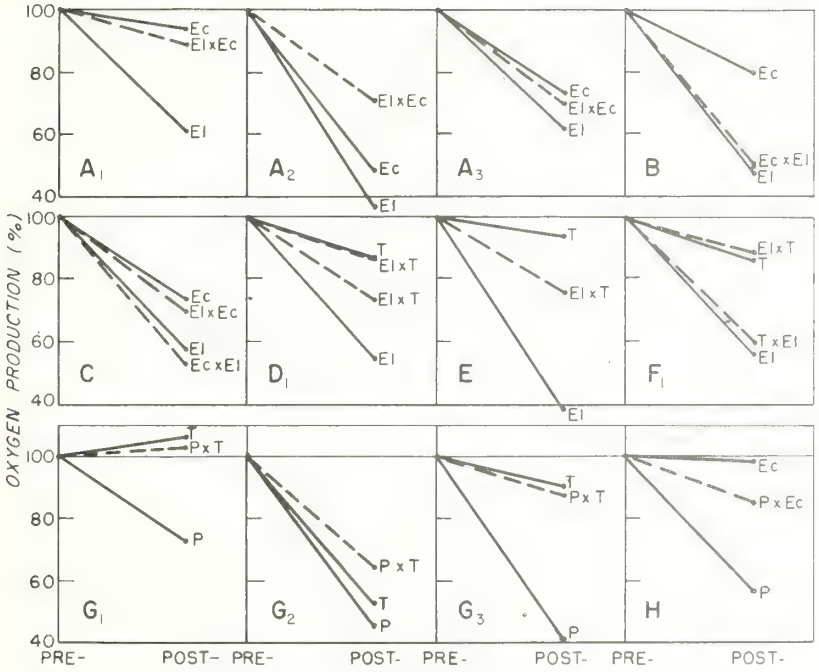

Figure 6.—*Post-dark 0_2 production of hybrids as a percentage of pre-dark production. Large letters denote plantations and smaller letters denote species and hybrids as stated in table 1. Subscripts indicate different sampling dates.*

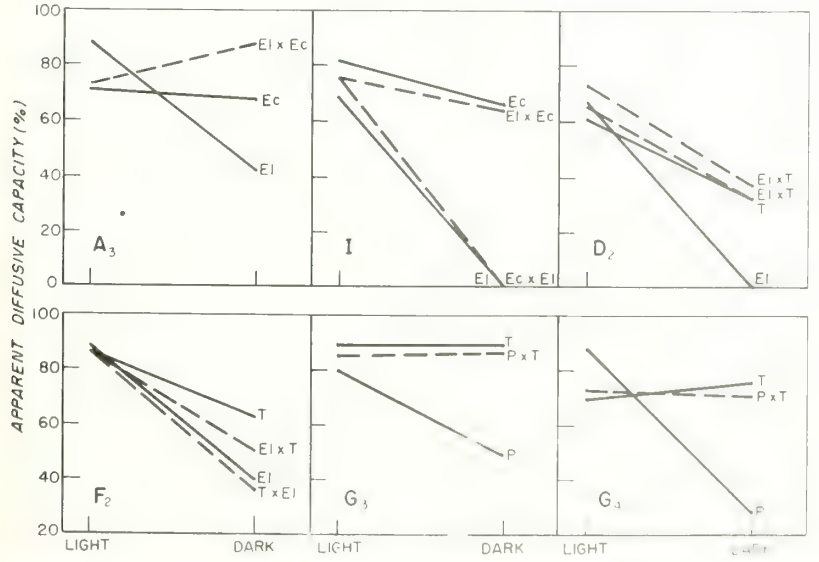

Figure 7.—*Apparent diffusive capacity of stomates of interspecific hybrids and their controls as measured by pressure-infiltration. Large letters denote plantations and smaller letters denote species and hybrids as stated in table 1. Subscripts indicate different sampling dates.*

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Oxygen production rates of detached needles were high during the season of needle formation, gradually declined during the first winter, peaked again in the second summer, and decreased thereafter. Longleaf and slash pine rates decreased more than loblolly and shortleaf rates following exposure to darkness and were also more sensitive to changes in temperature. Seasonal patterns of and species differences in stomatal activity generally paralleled those for oxygen production. Reactions of species hybrids generally were similar to those of the male parent species.

Additional keywords: *Pinus palustris, P. elliottii, P. taeda, P. echinata,* stomatal response.

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A Method for Appraising Multiple-Product sales of Southern Pine Stumpage

Walter C. Anderson

Southern Forest Experiment Station
Forest Service
U.S. Department of Agriculture

1976

A Method for Appraising Multiple-Product Sales of Southern Pine Stumpage

Walter C. Anderson

The appraisal-by-comparison method of estimating stumpage prices, previously applied only to single-product sales, was applied to multiple-product sales. Equations were developed to estimate the fair price for standing timber based on the amounts actually paid in similar sales in southern National forests. Four price zones were delineated and a separate estimating equation was developed for each. Average wholesale lumber price was the most important variable; several measures of tree size were also important. The estimating equations showed R^2 values ranging from .66 to .85 and standard errors of from $3.60 to $5.14, values comparable to those obtained for single product sales. The method can be applied directly to the sale of public timber and appears to be an adequate guide to stumpage valuation in private sales.

Additional keywords: Price, estimating equation, transaction analysis, appraisal by comparison.

Because of the economics of mechanized harvesting and increased emphasis on full-tree utilization, multiple-product stumpage sales are rapidly supplanting single-product sales. Though the trend is economically desirable, determining the market value of standing timber for multiple-product sales is more difficult than for single-product sales. Traditionally, the stumpage value of single-product sales is derived by deducting harvesting, transportation, and processing costs, plus an allowance for profit and risk, from the selling price of the product. However, applying this method to multiple-product sales is difficult because volumes and costs have to be determined separately for each product and the necessary data are frequently unavailable. An alternative method is "appraisal by comparison", in which the price set for a stand of timber is comparable to average prices established in previous transactions. Sometimes

referred to as the method of "transaction analysis" or "transaction evidence", the technique appears suitable for appraising multiple-product sales. It has been used previously for single-product sales—specifically sawtimber (Guttenberg 1956) and pulpwood (Row and Guttenberg 1961). The major advantages are availability of data, which are collected as a regular part of the sales procedures, and ease in application. The method also avoids the need to specify the values of end products or to determine costs yet recognizes changes in both.

The purpose of the present study was to determine the applicability of the appraisal-by-comparison method to multiple-product sales. In the study, equations were developed to estimate fair prices for standing timber based on prices actually paid for similar tracts. The equations, which include stand conditions and other factors influencing stumpage prices, apply only to lump sum sales.

Data

Stumpage prices were analyzed for 679 multiple-product sales of southern pine timber sold from National forests between 1969 and 1973:

Year	*Number of Sales*
1969	108
1970	121
1971	134
1972	163
1973	153

All data were from competitively priced commercial sales that included trees suitable for both sawtimber and pulpwood. Sales were excluded if the pulpwood volume was derived solely from tops of sawtimber-sized trees, if data needed for the analysis were lacking, if hardwoods comprised more than 10 percent of the volume, or if the sales were negotiated or special sales such as rights-of-way. The number of sales by National forests in each state were:

Location	*Number of Sales*
Alabama	22
Arkansas	238
Florida	62
Georgia	4
Louisiana	75
Mississippi	126
South Carolina	133
Texas	19

Information compiled for each sale included forest and ranger district, month and year of sale, number of bids, dollar amount of the winning bid, acreage to be cut, sawtimber volume, number of sawtimber trees, sawtimber trees by diameter class, pulpwood volume, number of pulpwood-size trees, and pulpwood-size trees by diameter class if known.

Sawtimber volume was expressed in board feet (Scribner); pulpwood volume was reported in cords in earlier years and in hundred cubic feet (CCF) later. For the analysis, all volumes were changed to equivalent cubic measure. Pulpwood volumes were converted on the basis of 76 cubic feet of solid wood per cord. Sawtimber volumes were converted using values in *Tables for Estimating Cubic Foot Volume of Timber* (Mesavage 1947) and *Tables for Estimating Board Foot Volumes of Timber* (Mesavage and Girard 1946), assuming a typical southern pine form class of 78.

Analysis

Variables

Previous analyses showed that stumpage prices vary with location, time, and stand conditions.

Location. — Prices vary by location because of differences in such factors as topography, road conditions, local competition among buyers, and proximity to mills — all of which are difficult to quantify. In the analysis, the National forests were grouped into four price zones according to similarities in average price, number of bids, acreage cut, volume per tree, proportion of volume in sawtimber, volume of sawtimber trees, and dispersion of trees by size as the criteria:

Price Zone	*State(s) Included*
Low	Arkansas
Medium low	Alabama, Florida, Georgia, South Carolina (Southeast)
Medium high	Mississippi
High	Louisiana, Texas

Separate price predicting equations were calculated for each price zone.

Time of sale. — Because the stumpage price level fluctuates, it was necessary to account for the temporal behavior of prices for the sales, which encompassed a 5-year period. Price changes over time were accounted for by including in the analysis the Bureau of Labor Statistics (BLS) average wholesale price for southern pine No. 2 dimension lumber—considered a reliable indicator of swings in the lumber market (fig. 1). Anticipated price changes were accounted

for by including changes in the lumber price for the previous 12-months. These two time variables were designated as follows:

P_L : Bureau of Labor Statistics (BLS) average wholesale price, in dollars per thousand board feet lumber tally, of southern pine No. 2 dimension lumber.

VP_L: 12-month change (to the month prior to sale) in BLS average wholesale price of southern pine No. 2 dimension lumber.

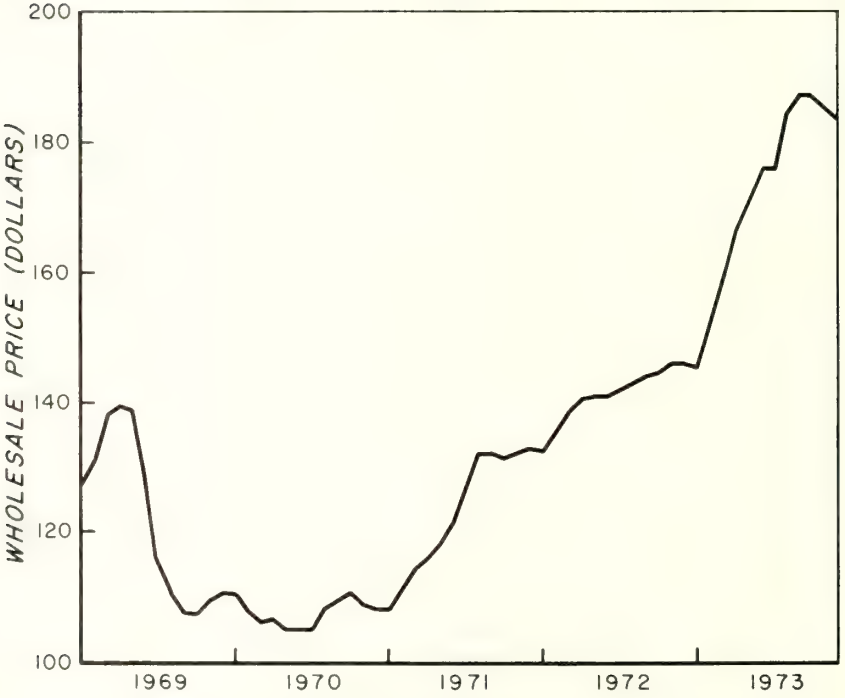

Figure 1.—*Bureau of Labor Statistics (BLS) average wholesale price for southern pine No. 2 dimension lumber, 1969-1973.*

Stand characteristics. — Stand characteristics influence stumpage prices by their effect on both harvesting costs and product alternatives. Twenty-one stand characteristics were chosen as independent variables for testing as possible price determinants. Of these, eight were obtained directly from sales records:

A = acreage cut
T_s = sawtimber trees
T_p = pulpwood trees
T = total trees
V_s = sawtimber volume (in CCF)
V_p = pulpwood volume (in CCF)
V = total volume (in CCF)
D = average diameter of sawtimber trees (in inches).

Thirteen additional variables were generated from the primary data:

V/T, T/V = average volume per tree and its reciprocal
V/A, A/V = volume per acre and its reciprocal
VxV/A = interaction of total volume and volume per acre
T/A, A/T = trees per acre and its reciprocal
Ts/T, T/Ts = proportion of sawtimber trees and its reciprocal
Vs/V, V/Vs = proportion of sawtimber volume and its reciprocal
Vs/Ts = average volume per sawtimber tree
$\Sigma D^2/\Sigma D$ = sum of diameters-squared divided by sum of diameters, for sawtimber trees.

Equations

For each price zone, a single-equation model was set up. The dependent variable, identified as P, was stumpage price, in dollars per hundred cubic feet (CCF). The form of each price model was:

P: $P_L + VP_L + A + Ts + Tp + T + Vs + Vp + V + D + V/T + T/V + V/A + A/V + VxV/A + T/A + A/T + Ts/T + T/Ts + Vs/V + V/Vs + Vs/Ts + \Sigma D^2/\Sigma D$

Conceptually, stumpage price is treated as a residual in the model. Lumber price is included because of the assumption that the price of stumpage in mixed product sales is derived largely from the demand for lumber. The model also includes elements influencing harvesting costs, which would be deducted from the product price to obtain the residual value for stumpage.

Results

Results of the analysis indicating the price determinants operating in each zone are shown in Table 1. A total of seven independent variables were significant for all price zones combined. The largest number occurred in the equation for the Southeast (six),

TABLE 1.—*Equations for estimating stumpage value of southern pine multiple-product sales in dollars per 100 cubic feet*

Price zone	Equations
Arkansas	$P = -53.3095 + 2.1874\ D + 0.2356\ P_L + 22.6536\ Vs/V$
Southeast	$P = -43.6653 + 16.7197\ D + 0.4356\ P_L - 0.1723\ VP_L - 0.7402\ T/V + 22.8874\ Vs/V - 15.6513\ \Sigma D^2/\Sigma D$
Mississippi	$P = -21.3645 + 0.2364\ P_L - 0.5960\ T/V + 27.7151\ Vs/V + 15.8843\ Vs/Ts$
Louisiana-Texas	$P = -132.2626 + 20.8999\ D + 0.4613\ P_L - 0.1552\ VP_L + 34.4979\ Vs/V - 14.8541\ \Sigma D^2/\Sigma D$

and the fewest in that for Arkansas (three). Two of the independent variables (P_L and Vs/V) appeared in all four equations, one (D) in three, three (T/V, $\Sigma D^2/\Sigma D$, VP_L) in two, and only one (Vs/Ts) in a single equation.

In each of the four equations, average wholesale lumber price (P_L) was the most important variable, reflecting the demand for both lumber and plywood in construction. In the Southeast and Louisiana-Texas price zones, the 12-month difference in lumber price (VP_L) was a significant independent variable, an indication that anticipated changes in lumber price infuenced the prices paid for stumpage.

Tree size, which was expressed in several forms, also had a great influence on price. The reciprocal of volume per tree (T/V), i.e., number of trees per hundred cubic feet, was significant in Mississippi and the Southeast, where stumpage price decreased as the number of trees per hundred cubic feet increased.

Most of the variables indicative of tree size pertained to sawtimber. Sawtimber volume as a proportion of total volume (Vs/V) was significant in all equations. Since large trees can be made into the most valuable products—lumber and plywood—stumpage price increased with greater proportions of sawtimber volume.

Average diameter of sawtimber trees (D) appeared in the equations for all price zones except Mississippi, and stumpage price rose with increases in the average diameter of sawtimber trees. Logging cost studies have consistently shown that it costs less per unit of volume of log trees of large diameter than those of small diameter.

In Mississippi, stumpage price increased with increasing average volume of sawtimber trees. A measure of diameter distribution ($\Sigma D^2/\Sigma D$) was significant in the Southeast and Louisiana-Texas.

Discussion

Effect of Competition on Price

Past studies have indicated that competition for timber, as measured by number of bids, is an important variable for explaining stumpage price. However, this factor cannot be used for prediction since it cannot be measured before the timber is offered for sale. Competition was not included in the appraisal equations, but the number of bids as obtained from sales records was tested in the analysis to determine the influence of competition on price behavior. The number of bids replaced no variables but was an additional significant variable in each explanatory equation. In all but the Southeast, it appeared in the stepwise regression immediately

after lumber price and sawtimber volume as a proportion of total volume. The proportion of price variation explained (R^2) and the standard error (SE) were:

Price zone	R^2		SE	
	Without number of bids	With number of bids	Without number of bids	With number of bids
Mississippi	0.85	0.87	3.56	3.32
Louisiana-Texas	.77	.82	6.62	5.83
Southeast	.77	.80	5.77	5.51
Arkansas	.66	.69	5.14	4.85

The differences were slight and of no practical importance when the number of bids was included in the equation.

Application

Application of the predicting equations is relatively simple. To apply the equation to a stand in Mississippi, for example, it is necessary to know total volume, total number of trees, sawtimber volume, and number of sawtimber trees—information normally collected when the sale is being set up. From these data, it is possible to compute the values needed for the three independent variables in the equation.

Application of the equation is illustrated by the following example: assume that the problem is to determine the value of a stand of timber in Mississippi in October 1973, if eight trees of average size are required to produce 100 cubic feet of bolts or logs, if sawtimber volume averages 20 cubic feet (or 0.2 CCF) per tree, and if 60 percent of the cubic foot volume is in sawtimber trees. When these values are inserted into the estimating equation for Mississippi, the result is:

$$P = -21.3645 + 0.2364\ (187.237) - 0.5960(8) + 27.7151\ (.60) + 15.8843\ (.20)$$

$$P = \$37.94$$

This is the estimated price in dollars per hundred cubic feet for the timber described above. The price is comparable to the amount paid for other stands sold in the Mississippi National Forests as of October 1973.

Setting a minimum price. — A seller needs to set an appraised price because stumpage is not always purchased by competitive bidding and because some offers attract only one bid. Setting a minimum price is not only required by law but is also dictated by com-

mon sense since valuable public timber might otherwise be sold below market value. Even when there is more than one bidder, a minimum price is needed to protect against collusion. Unless the appraisal is set at a nominal price, some and perhaps all bidders could be eliminated. Appraisal must be kept low enough to assure that the timber will be sold and that loggers will remain in business and compete for timber in future sales, but high enough to protect the public asset.

Since the estimated price is comparable to the prices being paid in other sales, it is representative of prices agreeable to a willing buyer and a willing seller in an open market transaction. But if the estimated price is used directly as the appraised price, there is a 50 percent chance the tract will not be sold. Since the estimated value is the average price buyers are willing to pay—half are willing to pay more and half less. The appraised price might be reduced below the estimated price by an amount equivalent to one standard error at the mean, expressed as a percentage.

Applying the equations to private sales. — The analysis presented here was based entirely on National forest sales. The applicability of the results to private sales was not tested primarily because of the difficulty of obtaining enough private sales records.

Public and private stumpage sales differ in that the minimum acceptable price in a private sale may be known only to the seller; whereas, in public sales, the minimum price is advertised. Also, National forest sales are usually larger than private ones, although the range in size overlaps considerably. In this study, there were 37 National forest sales of under 100 acres; some were less than ten.

Nevertheless, the price variables found significant in public timber sales should apply to private sales. Product prices and stand conditions affect stumpage price similarly regardless of ownership. Furthermore, average prices paid for National forest stumpage will not differ greatly from those paid for private stumpage. National forest timber cannot be more costly than private timber because the large blocks normally sold by National forests attract relatively few bidders. Also, private timber offers purchasers an alternative source of supply and therefore limits the price buyers must pay for public timber. On the other hand, National forest timber is not likely to be sold for less than private stumpage because sellers of public timber are never compelled to complete transactions. Moreover, the firm minimum price advertised with each offer to sell public timber does not permit prospective buyers to bid less than the advertised price.

Conclusion

Results of the analysis indicate that stumpage appraisal by comparison by means of statistically calculated estimating equations based on past sales can be applied to multiple-product sales. The method can be applied directly to the sale of public timber and appears to be an adequate guide to stumpage valuation in private sales.

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The appraisal-by-comparison method was used to develop equations to estimate the fair price for standing timber based on the amounts actually paid in similar sales in southern national forests. The values obtained for multiple-product sales were comparable to those obtained for single product sales. The method can be applied directly to the sale of public timber and appears to be an adequate guide to stumpage valuation in private sales.

Additional keywords: Price, estimating equation, transaction analysis, appraisal by comparison.

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Forest Service Research Paper SO-127

Hardwood Suitability for and Properties of Important Midsouth Soils

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Southern Forest Experiment Station
Forest Service
U.S. Department of Agriculture
1976

Hardwood Suitability for and Properties of Important Midsouth Soils

Walter M. Broadfoot[1]

SUMMARY

Tables present descriptions and properties of 40 important Midsouth soils and show management suggestions, occurrence, and suitability ratings of species.

Additional keywords: Site index, growth potential.

This paper updates and expands previous information (Broadfoot 1964) about important Midsouth soils and their suitability for hardwoods. Tables 1 through 40 present the description and properties of each soil and show management suggestions, occurrence, and suitability ratings of species. Because many good soils in the Midsouth have been cleared for agriculture, the majority of those included here are poorly drained clays, inaccessible, hilly, or frequently flooded. Species that have commercial timber value, are useful for wildlife, or are considered as forest weeds are included. Often a species that does not occur on a soil is listed when the soil has properties that are similar to those of soils on which the species does occur.

Soil properties were determined by currently accepted standard analytical procedures. Soil series were confirmed or reclassified according to the National Cooperative Soil Survey. Scientists from the Soil Conservation Service were consulted when soil identification was in doubt. The number for the Major Land Resource Area (MLRA) on which each soil occurs is presented in the description of the soil, and the areas are outlined in figure 1. Of the 40 soils, 16 occur primarily in the Southern Mississippi Valley Alluvium, 12 in the Silty Uplands, 9 in the Coastal Plains, and 3 in the Blackland Prairies.

Names of species are according to the Check List of Native and Naturalized Trees of the United States (Little 1953). The information on species is based primarily on observations during the past decade or so and on detailed measurements of more than 700 plots located throughout the Midsouth. Plots were on areas having uniform soil and well-stocked, even-aged stands that showed no evidence of having been cut or burned. Distribution of the soils among the plots was roughly proportional to the present importance of the soils for growing hardwoods.

The full range of height growth of each species was determined through observation of its growth on different soils and different sites. In setting the limits, the influence of local physiography, past use, and incidence of disease and insects were taken into account. The 20-foot range of the site indices is calculated to represent near-virgin site condition. Whether the height of a tree would be nearer the upper or lower end of the range depends upon local moisture conditions, individual stand characteristics, and genetic differences within species. Site index is height at 50 years, except for eastern cottonwood which is height at 30 years.

Site index for some species on some soils was calculated in an additional way. On plots where sweetgum was present, its average height was determined and related by regression to the average heights of species found growing with it (Broadfoot 1970). Thus, on plots where sweetgum and one or more of the other species was present, the site index of those that were not present was estimated.

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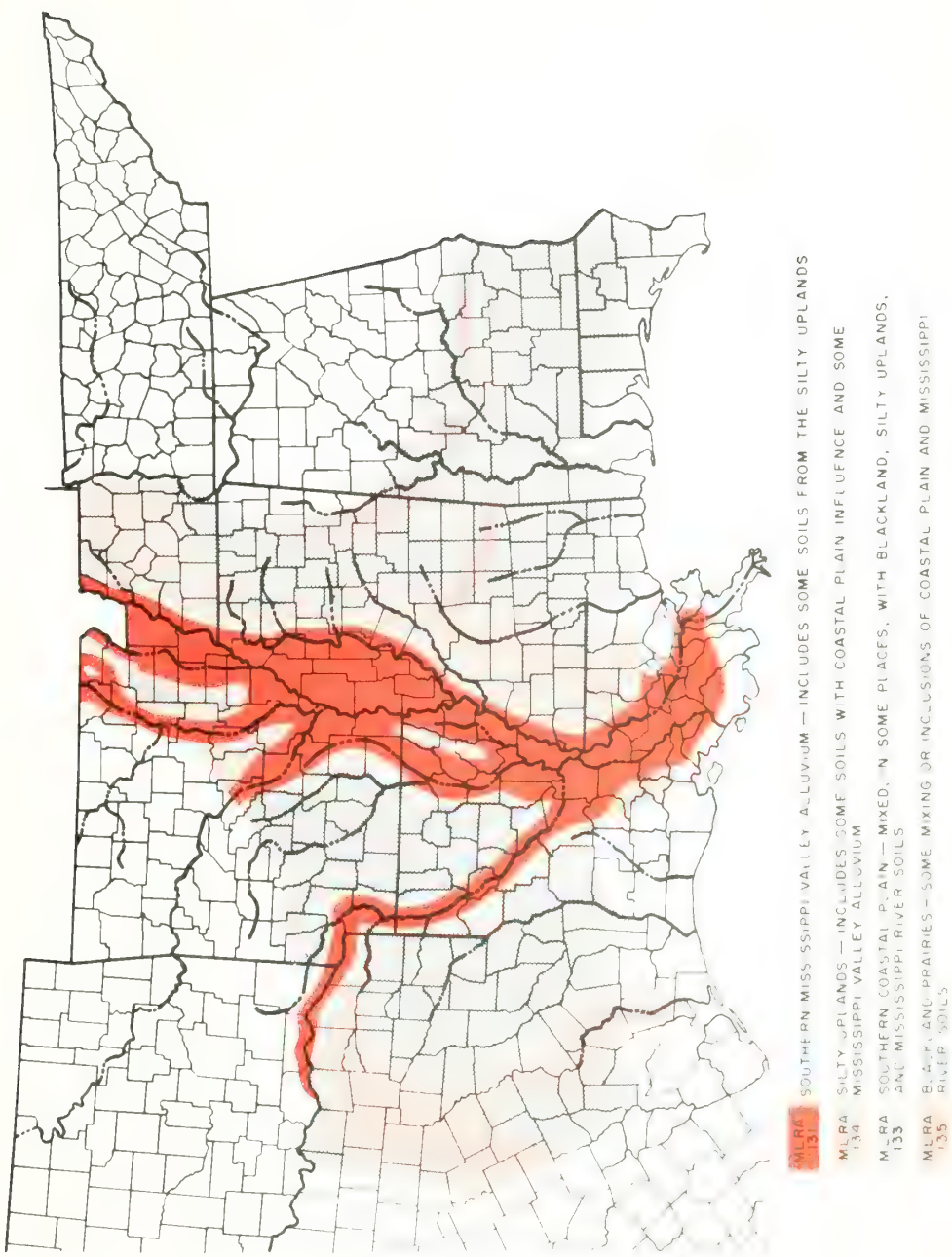
Figure 1.—*General location of the Major Land Resource Areas in the Midsouth where southern hardwoods are grown. The map is adapted from Austin (1965).*


MLRA 131 SOUTHERN MISSISSIPPI VALLEY ALLUVIUM — INCLUDES SOME SOILS FROM THE SILTY UPLANDS
MLRA 134 SILTY UPLANDS — INCLUDES SOME SOILS WITH COASTAL PLAIN INFLUENCE AND SOME MISSISSIPPI VALLEY ALLUVIUM
MLRA 133 SOUTHERN COASTAL PLAIN — MIXED, IN SOME PLACES, WITH BLACKLAND, SILTY UPLANDS, AND MISSISSIPPI RIVER SOILS
MLRA 135 BLACKLAND PRAIRIES — SOME MIXING OR INCLUSIONS OF COASTAL PLAIN AND MISSISSIPPI RIVER SOILS

EXPLANATION OF SYMBOLS

A+ Favor in management; suitable for planting; occurs frequently.

B+ Favor in management; occurs frequently.

C+ Manage but do not favor; occurs frequently.

D+ Weed species on this soil; retain if useful for wildlife; occurs frequently.

A Favor in management; suitable for planting; occurs occasionally.

B Favor in management; occurs occasionally.

C Manage, but do not favor; occurs occasionally.

D Weed species on this soil; retain if useful for wildlife; occurs occasionally.

1 Best growth; among the top soil-species combinations for production.

1-2 Growth ranges from best to good.

2 Good productivity with proper management.

2-3 Growth ranges from good to fair.

3 Fair to poor growth.

3-4 Poor to unsuited.

4 Unsuited.

( ) Species is not known to occur naturally on this soil. Suitability rating is by opinion.

Table 1.—*The ADLER series is a member of the coarse-silty, mixed, nonacid, thermic family of Aquic Udifluvents. These soils occur chiefly in narrow to broad floodplains within the Silty Uplands (MLRA-134), on slopes of 0 to 2 percent. They are moderately well drained, with gray mottles beginning at about 16 inches' depth. If surface layers of soil are above pH 7.5, it should be considered unsuitable for planting oaks.*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	5.0	5.5	6.0	6.3
Phosphorus, extractable	p/m	20	18	17	18
Potassium, extractable	p/m	34	34	30	32
Sodium, extractable	p/m	14	16	18	28
Soluble salts	mmho/cm	6	6	8	7
Organic matter	%/wt	1.20	.72	.86	.70
Cation exchange capacity	me/100 g	8.4	8.8	6.6	6.8
Exchangeable calcium	me/100 g	3.1	4.4	4.0	3.9
Exchangeable magnesium	me/100 g	1.8	2.1	1.6	1.9
Ca:Mg ratio		1.72	2.09	2.50	2.05
Base saturation	%	62	76	86	90
Sand	%/wt	14	20	39	33
Silt	%/wt	72	64	47	53
Clay	%/wt	14	16	14	14
Bulk density	g/cc	1.24	1.42	1.48	1.46
Moisture equivalent	%/vol	25	30	27	28
60-cm moisture	%/vol	38	40	39	37
15-bar moisture	%/vol	8	10	7	8
Usable water after drainage	%/vol	30	30	32	29
Total porosity	%/vol	53	46	44	45
Pore volume for potential drainage and aeration	%/vol	15	6	5	8

Table 1a.—*Species suitability and productivity on ADLER soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green	A+	1	105- 85		84
Baldcypress	C	1-2	110- 90		
Birch, river		(2)	85- 65		
Boxelder	C				
Catalpa	C				
Cherry, black	C	2	95- 75		
Chinaberry	C				
Cottonwood, eastern	A	1	130-110		95
Elms, American and slippery	C+	1	95- 75		
Hackberry and sugarberry	B	1	100- 80		
Honeylocust	C	1	95- 75		
Locust, black	C				
Maple, red	C	2	90- 70		
Mulberry	C				
Oak, bur	C				
Oak, cherrybark	B	1-2	115- 95	100	98
Oak, Nuttall	B	1-2	115- 95	114	94
Oak, pin	C				
Oak, water	B	1-2	110- 90		92
Oak, willow	B	1-2	110- 90	94	96
Pecan	B	2	100- 80		
Persimmon, common	C	2	85- 65		
Red cedar, eastern	C				
Sassafras	C	2	95- 75		
Sweetgum	A+	1-2	110- 90	95	
Sycamore, American	A+	1	125-105	110	
Walnut, black	B	1	100- 80	88	
Willow, black	B	2	90- 70		
Yellow-poplar	B	1-2	115- 95	102	

Table 2.—*The ALLIGATOR series is a member of the very fine, montmorillonitic, acid, thermic family of Vertic Haplaquepts. It occurs in slackwater sediments from Mississippi River alluvium. The series consists of poorly drained, fine-textured soil on floodplains and in depressions or old drainageways. The surface layer is gray clay and subsoil is mottled gray clay. Slopes range from 0 to 3 percent (MLRA-131). If waterlogged throughout one or more growing seasons, it is unsuitable for hardwoods. There should be no free water in the surface foot of soil during July, August, or September to obtain productivity within the estimated range*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	5.1	5.0	5.0	5.5
Phosphorus, extractable	p/m	16	13	11	14
Potassium, extractable	p/m	268	222	218	192
Sodium, extractable	p/m	102	161	236	264
Soluble salts	mmho/cm	33	19	58	112
Organic matter	%/wt	2.63	1.20	1.00	0.77
Cation exchange capacity	me/100 g	42.9	44.7	43.9	36.8
Exchangeable calcium	me/100 g	19.7	19.7	20.6	19.9
Exchangeable magnesium	me/100 g	10.2	12.6	14.5	13.8
Ca:Mg ratio		1.94	1.64	1.48	1.50
Base saturation	%	72.4	75.8	83.9	96.9
Sand	%/wt	12	8	8	9
Silt	%/wt	23	22	22	28
Clay	%/wt	64	70	70	63
Bulk density	g/cc	1.06	1.18	1.20	1.27
Moisture equivalent	%/vol	51	56	55	52
60-cm moisture	%/vol	56	56	55	52
15-bar moisture	%/vol	30	34	34	33
Usable water after drainage	%/vol	26	22	21	19
Total porosity	%/vol	60	56	55	52
Pore volume for potential drainage and aeration	%/vol	4	0	0	0

Table 2a—*Species suitability and productivity on ALLIGATOR soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green	A+	2	90- 70	80	79
Baldcypress	B	2	95- 75	88	
Boxelder	C				
Buttonbush	D				
Catalpa	C				
Cottonwood, eastern	A	3	100- 80	92	88
Cottonwood, swamp	C				
Dogwood, roughleaf	D+				
Elms, American and slippery	C+	2	85- 65	74	
Elms, winged and cedar	C	2	75- 55	65	
Hackberry and sugarberry	C+	2-3	85- 65	76	
Hawthorn	D				
Hickories (except water)	C	2-3	80- 60	77	
Hickory, water	C+	2	90- 70	87	
Honeylocust	C+	1-2	90- 70	82	
Maple, red	C	3-4	75- 55	65	
Mulberry	C				
Oak, cherrybark	B	2	100- 80	86	94
Oak, laurel		(1-2)	105- 85		
Oak, Nuttall	A+	2	100- 80	88	89
Oak, overcup	C+	2	85- 65	77	
Oak, Shumard		(3)	95- 75		
Oak, swamp chestnut	C	2-3	85- 65	70	
Oak, swamp post	C	2	85- 65	74	
Oak, water	B+	2	95- 75	83	90
Oak, willow	B+	2	100- 80	88	92
Pecan	C	3	90- 70		
Persimmon, common	C	2-3	80- 60	76	
Redbud	D				
Swamp-privet	D+				
Sweetgum	A+	2-3	95- 75	89	
Sycamore, American	A	3	95- 75		
Tupelo, black and swamp	C	2	85- 65		
Tupelo, water	C+	2	90- 70		
Willow, black	C	2	90- 70	84	
Yellow-poplar		(4)	<65		

Table 3.—*The AMAGON series is a member of the fine-silty, mixed, thermic family of Typic Ochraqualfs. These poorly drained acid soils occur mostly on slopes of 0 to 3 percent within MLRA-131, the Mississippi River floodplain*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	4.8	5.0	5.1	5.2
Phosphorus, extractable	p/m	9	8	18	23
Potassium, extractable	p/m	138	134	148	97
Sodium, extractable	p/m	48	88	108	119
Soluble salts	mmho/cm	22	12	19	20
Organic matter	%/wt	1.44	.78	.55	.46
Cation exchange capacity	me/100 g	21.8	28.4	25.6	20.4
Exchangeable calcium	me/100 g	9.2	11.8	12.2	10.4
Exchangeable magnesium	me/100 g	3.4	5.8	6.0	5.0
Ca:Mg ratio		2.80	2.07	2.04	2.06
Base saturation	%	60.6	66.0	75.2	80.2
Sand	%/wt	24	22	32	45
Silt	%/wt	42	39	36	28
Clay	%/wt	34	38	32	27
Bulk density	g/cc	1.18	1.24	1.32	1.30
Moisture equivalent	%/vol	35	40	40	31
60-cm moisture	%/vol	40	45	42	40
15-bar moisture	%/vol	19	23	21	16
Usable water after drainage	%/vol	21	22	21	24
Total porosity	%/vol	56	53	50	51
Pore volume for potential drainage and aeration	%/vol	16	8	8	11

Table 3a.—*Species suitability and productivity on AMAGON soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green	A	2	95- 75		81
Baldcypress	B	2	95- 75		
Basswood, American	C	2	95- 75		
Buttonbush	D				
Cottonwood, eastern	A	2	105- 85		91
Cottonwood, swamp	C				
Elms	C	2	90- 70		
Hackberry and sugarberry	C	2	90- 70		
Hawthorn	D				
Hickories	C	1	95- 75		
Honeylocust	C	2	85-65		
Hophornbeam, eastern	D				
Maple, red		(1-2)	95- 75		
Oak, cherrybark	B+	2	105- 85	94	97
Oak, laurel	B	2	100- 80		
Oak, Nuttall	A	2	105- 85		92
Oak, overcup	B	2	85- 65	70	
Oak, Shumard	B	2	100- 80	89	
Oak, swamp chestnut	B	2	95- 75		
Oak, water	B+	2	100- 80	90	92
Oak, white		(2)	100- 80		
Oak, willow	B+	2	100- 80	90	93
Pecan		(2)	100- 80		
Persimmon, common	C	2	85- 65		
Redbud	D				
Redcedar, eastern	C				
Sassafras	C	3	90- 70		
Swamp-privet	D				
Sweetgum	A+	2	105- 85	92	
Sycamore, American	A	2	110- 90		
Tupelo, black	B	2	90- 70	80	
Tupelo, water	A	2	90- 70		
Willow, black	C	2	90- 70		
Yellow-poplar		(2)	100- 80		

Table 4.—*The ARKABUTLA series is a member of the fine-silty, mixed, acid, thermic family of Aeric Fluvaquents. These somewhat poorly drained soils usually occur on slopes of 0 to 2 percent in floodplains within the Silty Uplands (MLRA-134)*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	4.9	4.9	5.0	5.2
Phosphorus, extractable	p/m	10	8	10	9
Potassium, extractable	p/m	50	34	36	41
Sodium, extractable	p/m	19	30	40	84
Soluble salts	mmho/cm	9	7	7	12
Organic matter	% wt	1.97	.92	.80	.65
Cation exchange capacity	me/100 g	11.6	10.3	10.2	8.0
Exchangeable calcium	me/100 g	4.57	3.60	3.39	2.32
Exchangeable magnesium	me/100 g	2.12	1.90	1.66	1.20
Ca:Mg ratio		2.20	1.75	1.87	1.74
Base saturation	%	59.0	54.4	49.6	45.2
Sand	%/wt	16	21	20	20
Silt	%/wt	55	53	52	52
Clay	%/wt	28	26	28	28
Bulk density	g/cc	1.21	1.32	1.34	1.37
Moisture equivalent	%/vol	35	33	34	34
60-cm moisture	%/vol	43	42	43	42
15-bar moisture	%/vol	14	12	13	14
Usable water after drainage	%/vol	29	30	30	28
Total porosity	%/vol	54	50	50	49
Pore volume for potential drainage and aeration	%/vol	11	8	7	7

Table 4a.—*Species suitability and productivity on ARKABUTLA soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green and white	A+	1	105- 85	89	83
Baldcypress	C	2	95- 75		
Basswood, American		(2)	95- 75		
Beech, American	C				
Buckeye	D				
Buttonbush, common	D				
Cherry, black	C	2	95- 75		
Cottonwood, eastern	A	1-2	120-100		95
Cottonwood, swamp	C				
Dogwood, flowering	C				
Elderberry	D				
Elms	C+	1	90- 70	77	
Hackberry and sugarberry	C	2-3	80- 60	70	
Hawthorn	D				
Hickories	C+	1-2	95- 75	80	
Holly, American	C				
Honeylocust	C	1	95- 75	85	
Hophornbeam, eastern	D				
Hornbeam, American	D				
Locust, black	C				
Maple, red	C+	2	90- 70	80	
Mulberry	C				
Oak, cherrybark	B+	1-2	115- 95	96	98
Oak, laurel	B	2	100- 80		
Oak, Nuttall	A	1	120-100	112	93
Oak, overcup	B	1	100- 80	90	
Oak, pin	C				
Oak, Shumard	B	2	110-90		
Oak, swamp chestnut	B+	1-2	100- 80	86	
Oak, water	B+	1-2	110- 90	93	93
Oak, white	B	2	100- 80		
Oak, willow	B+	1-2	110- 90	104	95
Pecan		(2)	100- 80		
Persimmon, common	C	2	85- 65		
Pine, spruce	C				
Redcedar, eastern	C				
Sassafras		(2)	95- 75		
Swamp-privet	D				
Sweetgum	A+	1-2	110- 90	94	
Sycamore, American	A	2	115- 95	105	
Tupelo, black	C	2	85- 65		
Tupelo, swamp	C				
Tupelo, water		(2)	90- 70		
Willow, black	C	2	90- 70	85	
Yellow-poplar	C	2	100- 80		

Table 5.—*The ASKEW series is a member of the fine-silty, mixed, thermic family of Aquic Hapludalfs. These somewhat poorly drained acid soils occur on gently sloping, old natural levees within MLRA-131, the Southern Mississippi Alluvial Valley*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	5.4	5.2	5.4	5.4
Phosphorus, extractable	p/m	20	35	52	53
Potassium, extractable	p/m	143	101	86	94
Sodium, extractable	p/m	6	18	16	16
Soluble salts	mmho/cm	0	0	0	0
Organic matter	%, wt	2.39	.70	.42	.55
Cation exchange capacity	me/100 g	19.0	15.8	12.5	13.7
Exchangeable calcium	me/100 g	10.95	7.80	6.53	7.95
Exchangeable magnesium	me/100 g	3.20	2.09	1.72	2.21
Ca:Mg ratio		3.42	3.73	3.80	3.60
Base saturation	%	77.9	65.8	69.6	77.4
Sand	%/wt	27	42	45	32
Silt	%/wt	41	33	36	47
Clay	%/wt	32	25	19	21
Bulk density	g/cc	1.32	1.47	1.35	1.38
Moisture equivalent	%/vol	38	35	27	32
60-cm moisture	%/vol	39	36	36	38
15-bar moisture	%/vol	18	15	11	13
Usable water after drainage	%/vol	21	21	25	25
Total porosity	%/vol	50	45	49	48
Pore volume for potential drainage and aeration	%/vol	11	9	13	10

Table 5a.—*Species suitability and productivity on ASKEW soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green	A	2	90- 70		79
Basswood, American	B	2	95- 75		
Birch, river	C	3	80- 60		
Boxelder	C				
Catalpa	C				
Cherry, black		(2)	95- 75		
Chinaberry	C				
Cottonwood, eastern	A	2	110- 90		89
Dogwood, flowering and roughleaf	D				
Elms	C	1	90- 70		
Hackberry and sugarberry	C	1	100- 80		
Hawthorn	D				
Hickories (except water)	B	1	95- 75		
Honeylocust		(2)	85- 65		
Hophornbeam, eastern	D				
Hornbeam, American	D				
Locust, black	C				
Maple, red	C	2	90- 70		
Mulberry	C				
Oak, cherrybark	B+	1-2	115- 95	100	93
Oak, laurel	B	1-2	105- 85		
Oak, Nuttall	A	2	110- 90		89
Oak, overcup		(2)	85- 65		
Oak, Shumard	A	1	115- 95		
Oak, swamp chestnut	B	1-2	100- 80		
Oak, water	B+	1-2	110- 90	98	90
Oak, white		(1)	110- 90		
Oak, willow	B+	1-2	110- 90	94	92
Pawpaw	D				
Prickly-ash	D				
Pecan	B	1	105- 85		
Persimmon, common	C	3	75- 55		
Redbud	D				
Sassafras	B	2	95- 75		
Sumac, smooth	D				
Swamp-privet	D				
Sweetgum	A+	1-2	110- 90	90	
Sycamore, American	A	1-2	120-100		
Tupelo, black	C	2	85- 65	70	
Tupelo, water		(2)	90- 70		
Walnut, black	B	2	95- 75		
Yellow-poplar		(2)	100- 80		

Table 6.—*The BRUNO series is a member of the sandy, mixed, thermic family of Typic Udifluvents. These well-drained soils occur in streams and floodplains of the Silty Uplands (MLRA-134) and Mississippi River Alluvium (MLRA-131); slopes do not exceed 5 percent. If located on physiographically dry situations, these soils are not suitable for hardwoods*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	5.4	5.4	5.4	5.1
Phosphorus, extractable	p/m	2	2	3	2
Potassium, extractable	p/m	28	15	18	21
Sodium, extractable	p m	21	14	13	15
Soluble salts	mmho/cm	12	10	10	11
Organic matter	% wt	.95	.78	.55	.55
Cation exchange capacity	me/100 g	3.8	3.6	2.4	2.7
Exchangeable calcium	me/100 g	1.35	1.79	1.26	1.39
Exchangeable magnesium	me/100 g	0.79	0.66	0.32	0.42
Ca:Mg ratio		1.71	2.71	3.94	3.31
Base saturation	%	60.5	69.4	66.7	70.4
Sand	% wt	57	67	82	78
Silt	%/wt	35	25	14	16
Clay	%/wt	8	8	4	6
Bulk density	g/cc	1.34	1.37	1.40	1.41
Moisture equivalent	%/vol	16	15	10	11
60-cm moisture	%/vol	30	26	20	20
15-bar moisture	%/vol	4	4	4	4
Usable water after drainage	%/vol	26	22	16	16
Total porosity	%/vol	50	48	47	47
Pore volume for potential drainage and aeration	% vol	20	22	27	27

Table 6a.—*Species suitability and productivity on BRUNO soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green and white	C	3	75- 55		
Basswood, American		(1-2)	100- 80		
Birch, river	C	2	85- 65		
Cherry, black	B	1-2	100- 80	95	
Cottonwood, eastern	A	3	100- 80		
Dogwood, flowering	C				
Elms	C+	2	75- 55		
Hackberry and sugarberry	B	2	90- 70		
Hawthorn	D				
Hickories (except water)	B	2	90- 70		
Holly, American	C				
Honeylocust		(3)	80- 60		
Hophornbeam, eastern	D				
Hornbeam, American	D				
Locust, black	C				
Magnolia, southern	C				
Maple, red and silver	C	3	85- 65		
Mulberry	C				
Oak, cherrybark	B+	1-2	120-100	116	114
Oak, Nuttall		(2)	110- 90		
Oak, overcup		(3)	80- 60		
Oak, Shumard		(2)	110- 90		
Oak, southern red	C				
Oak, swamp chestnut	B	2	95- 75		
Oak, water	B+	1-2	110- 90	100	109
Oak, white	B	2	100- 80		
Oak, willow	B	1-2	110- 90		108
Pecan	B	2	100- 80		
Persimmon, common	C	3	75- 55		
Sassafras	C	2	95-75		
Sumac, smooth	D				
Sweetgum	A+	1-2	120-100	115	
Sycamore, American	A	1-2	125-105	110	
Tupelo, black	C	2	85- 65		
Walnut, black		(2)	95- 75		
Yellow-poplar	B	1	125-105	118	

Table 7.—*The BUXIN series is a member of the fine, mixed, thermic family of Vertic Hapludolls. They are nonacid, poorly drained, and occur in the MLRA-131 where red alluvial sediments overlie gray Mississippi River sediments*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	5.8	5.9	6.6	6.8
Phosphorus, extractable	p/m	19	19	11	13
Potassium, extractable	p/m	266	216	156	195
Sodium, extractable	p/m	79	136	202	315
Soluble salts	mmho/cm	40	80	58	132
Organic matter	%/wt	3.69	1.65	1.25	.70
Cation exchange capacity	me/100 g	39.4	38.2	28.3	34.9
Exchangeable calcium	me/100 g	23.10	22.20	18.60	21.98
Exchangeable magnesium	me/100 g	10.64	10.64	7.50	9.59
Ca:Mg ratio		2.17	2.09	2.48	2.29
Base saturation	%	88.3	89.0	97.5	97.7
Sand	%/wt	15	12	14	11
Silt	%/wt	26	29	39	26
Clay	%/wt	59	59	47	63
Bulk density	g/cc	1.08	1.20	1.36	1.34
Moisture equivalent	%/vol	45	48	44	54
60-cm moisture	%/vol	51	52	43	50
15-bar moisture	%/vol	31	31	27	34
Usable water after drainage	%/vol	20	21	16	16
Total porosity	%/vol	59	55	49	50
Pore volume for potential drainage and aeration	%/vol	8	3	6	0

Table 7a.—*Species suitability and productivity on BUXIN soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green	A+	2-3	85- 65	67	
Baldcypress	C	2	95- 75		
Boxelder	C				
Chittamwood	C				
Cottonwood, eastern	A+	2-3	105- 85		
Dogwood, roughleaf	D				
Elms, American and slippery	C+	2	75- 55		
Hackberry and sugarberry	C+	2	90- 70		
Hickories	C	2	90- 70	82	
Honeylocust	C	1-2	90- 70	82	
Maple, red	C	3	85- 65		
Mulberry	C				
Oak, cherrybark	C	3	95- 75	88	
Oak, Nuttall	C	2-3	95- 75	83	
Oak, overcup	C	2	85- 65		
Oak, Shumard	C	3	95- 75	89	
Oak, swamp chestnut	C	3	85- 65	75	
Oak, water	C	2-3	95- 75		
Oak, willow	C	2-3	95- 75	89	
Osage-orange	C				
Pecan	C	2	100- 80		
Persimmon, common	C	2	85- 65		
Planertree	D				
Swamp-privet	D				
Sweetgum	A	2-3	95- 75		
Sycamore, American	A	2-3	100- 80		
Willow, black	C	2	90- 70		
Yellow-poplar		(3)	85- 65		

Table 8.—*The CALLOWAY series is a member of the fine-silty, mixed, thermic family of Glossaquic Fragiudalfs. These somewhat poorly drained acid soils have a fragipan at 14 to 36 inches. They occur on level topography in the Silty Uplands (MLRA-134)*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	4.9	5.0	5.2	5.2
Phosphorus, extractable	p/m	55	27	17	20
Potassium, extractable	p/m	30	29	90	70
Sodium, extractable	p/m	24	48	176	224
Soluble salts	mmho/cm	12	14	16	23
Organic matter	%/wt	1.29	.35	.38	.21
Cation exchange capacity	me/100 g	7.7	8.1	18.0	17.5
Exchangeable calcium	me/100 g	0.77	0.62	2.66	3.30
Exchangeable magnesium	me/100 g	0.63	0.90	3.61	4.00
Ca:Mg ratio		1.22	0.69	0.74	0.82
Base saturation	%	20.8	23.5	40.0	47.4
Sand	%/wt	15	15	9	10
Silt	%/wt	71	65	62	63
Clay	%/wt	14	20	29	27
Bulk density	g/cc	1.09	1.15	1.15	1.14
Moisture equivalent	%/vol	26	26	34	34
60-cm moisture	%/vol	41	36	40	42
15-bar moisture	%/vol	7	8	17	15
Usable water after drainage	%/vol	34	28	23	27
Total porosity	%/vol	59	57	57	57
Pore volume for potential drainage and aeration	%/vol	18	21	17	15

Table 8a.—*Species suitability and productivity on CALLOWAY soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green and white	C	3	75- 55	68	68
Cottonwood		(4)	<75		
Dogwood, flowering	D				
Elms	C	3	70- 50	60	
Hackberry		(3)	75- 55		
Hawthorn	D				
Hickories (except water)	C+	2	85- 65	80	
Holly, American	C	3			
Honeylocust		(3)	80- 60		
Hophornbeam, eastern	D				
Hornbeam, American	D				
Locust, black	C				
Maple, red	C	3	85- 65		
Oak, blackjack	D				
Oak, cherrybark	B+	3	90- 70	78	84
Oak, Nuttall	A	3	90- 70		76
Oak, overcup		(3)	80- 60		
Oak, post	C				
Oak, Shumard	A	3	90- 70	80	
Oak, southern red	C	3	85- 65	75	
Oak, swamp chestnut		(3)	85- 65		
Oak, water	C	3	85- 65	83	81
Oak, white	C	3	80- 60	70	
Oak, willow	C	3	85- 65		83
Pecan		(3)	90- 70		
Persimmon, common	C	3	75- 55		
Redcedar, eastern	C				
Sweetgum	A+	3	90- 70	76	
Sycamore, American	C	3	85- 65	75	
Tupelo, black	C	3	80- 60	65	
Yellow-poplar	C	3	85- 65	75	

Table 9.—*The CASCILLA series is a member of the fine-silty, mixed, thermic family of Fluventic Dystrochrepts. These well-drained, acid soils occur on high areas bordering old stream channels within the Silty Uplands (MLRA-134). Slopes range from 0 to 2 percent*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	5.0	4.9	5.0	4.9
Phosphorus, extractable	p/m	5	6	8	10
Potassium, extractable	p/m	92	38	31	31
Sodium, extractable	p/m	16	25	26	22
Soluble salts	mmho/cm	18	23	18	23
Organic matter	%/wt	2.08	1.25	.74	.90
Cation exchange capacity	me/100 g	13.0	8.8	6.5	6.4
Exchangeable calcium	me/100 g	3.81	1.73	1.13	1.25
Exchangeable magnesium	me/100 g	2.35	1.16	0.80	0.74
Ca:Mg ratio		1.62	1.49	1.41	1.69
Base saturation	%	50.0	35.2	33.8	34.4
Sand	%/wt	11	13	14	16
Silt	%/wt	59	62	70	68
Clay	%/wt	30	25	16	16
Bulk density	g/cc	1.08	1.33	1.33	1.34
Moisture equivalent	%/vol	32	37	33	34
60-cm moisture	%/vol	37	44	42	42
15-bar moisture	%/vol	12	10	7	7
Usable water after drainage	%/vol	25	34	35	35
Total porosity	%/vol	59	50	50	50
Pore volume for potential drainage and aeration	%/vol	22	6	8	8

Table 9a.—*Species suitability and productivity on CASCILLA soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green and white	A	1-2	100- 80	96	95
Basswood, American	C	2	95- 75		
Beech, American	C				
Birch, river		(2)	85- 65		
Catalpa	C				
Cherry, black	B	2	95- 75		
Cottonwood, eastern	A	1-2	120-110		108
Dogwood, flowering	C				
Elms	C+	2	75- 55		
Hackberry and sugarberry	C	2	90- 70		
Hickories (except water)	C+	1	95- 75		
Holly, American	C				
Honeylocust		(2)	85- 65		
Hophornbeam, eastern	D				
Hornbeam, American	D				
Locust, black	C				
Magnolia, southern	C				
Maple, red	C	2	90- 70		
Mulberry	C				
Oak, cherrybark	B+	1	125-105	120	110
Oak, laurel		(2)	100- 80		
Oak, Nuttall	A	1-2	115- 95		108
Oak, overcup		(2)	85-65		
Oak, Shumard	A	1	120-100	111	
Oak, southern red	C				
Oak, swamp chestnut	B	1	110- 90	105	
Oak, water	B+	1	115- 95	111	105
Oak, white	B	1	110- 90		
Oak, willow	B	1	115- 95		104
Pecan	C	1	110- 90		
Persimmon, common	C	2	85- 65		
Prickly-ash	D				
Redbud	D				
Redcedar, eastern	C				
Sassafras	C	2	95- 75		
Sumac, smooth	D				
Sweetgum	A+	1	115- 95	110	
Sycamore, American	A	1	125-105		
Tupelo, black	C	2	85- 65		
Tupelo, water		(2)	90- 70		
Walnut, black	C	2	95- 75		
Yellow-poplar	A+	1	125-105	116	

Table 10.—*The CHENNEBY series is a member of the fine-silty, mixed, thermic family of Fluvaquentic Dystrochrepts. These somewhat poorly-drained acid soils occur in floodplains on slopes of 0 to 2 percent within the Coastal Plains and Silty Uplands (MLRA-133, -134)*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	5.1	5.1	5.0	5.0
Phosphorus, extractable	p/m	9	10	13	14
Potassium, extractable	p/m	66	40	35	42
Sodium, extractable	p m	34	30	42	59
Soluble salts	mmho/cm	11	8	8	9
Organic matter	% wt	1.70	1.02	.95	.76
Cation exchange capacity	me/100 g	10.2	7.4	6.8	7.4
Exchangeable calcium	me/100 g	3.84	2.08	1.76	1.56
Exchangeable magnesium	me/100 g	2.09	1.33	1.24	1.50
Ca:Mg ratio		1.82	1.54	1.44	1.11
Base saturation	%	60.0	48.3	48.0	44.8
Sand	% wt	12	14	16	18
Silt	%/wt	64	63	61	60
Clay	%/wt	24	23	23	22
Bulk density	g/cc	1.28	1.36	1.38	1.42
Moisture equivalent	%/vol	33	34	34	34
60-cm moisture	%/vol	40	43	42	40
15-bar moisture	%/vol	12	11	12	12
Usable water after drainage	%/vol	28	32	30	28
Total porosity	% vol	52	49	48	46
Pore volume for potential drainage and aeration	%/vol	12	6	6	6

Table 10a.—*Species suitability and productivity on CHENNEBY soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green and white	A+	1	100- 80	92	89
Baldcypress		(2)	95- 75		
Basswood, American		(2)	95- 75		
Beech, American	D				
Birch, river	C+	1	90- 70	78	
Boxelder	C	2	75- 55	65	
Buckeye	D				
Cherry, black	C	2	95- 75		
Cottonwood, eastern	A	2	115- 95		100
Dogwood, flowering	C				
Elderberry	D				
Elms	C+	1	95- 75	90	
Hackberry		(2)	90- 70		
Hickories (except water)	B+	1	95- 75		
Holly, American	C	3-4			
Honeylocust		(2)	85- 65		
Hophornbeam, eastern	D				
Hornbeam, American	D+				
Locust, black	C				
Maple, red	B	1-2	95- 75	80	
Mulberry	C				
Oak, cherrybark	B+	1-2	115- 95	104	103
Oak, laurel		(1-2)	105- 85		
Oak, Nuttall	A	1-2	115- 95	102	101
Oak, overcup		(1)	100- 80		
Oak, post	C				
Oak, Shumard	A	1-2	115- 95	111	
Oak, southern red	C				
Oak, swamp chestnut	B	1-2	100- 80	85	
Oak, water	B+	1	110- 90	102	100
Oak, white	B	1-2	100- 80	88	
Oak, willow	B	1-2	105- 85	93	100
Pecan	B	2	100- 80	90	
Persimmon, common	C	2	85- 65	75	
Redbud	D				
Sassafras	C	2	95- 75		
Sweetgum	A+	1-2	110- 90	102	
Sycamore, American	A	1-2	115- 95	108	
Tupelo, black	C	2	85- 65	70	
Tupelo, water		(2)	90- 70		
Walnut, black		(2)	95- 75		
Willow, black		(2)	90- 70		
Yellow-poplar	A	1-2	115- 95	108	

Table 11.—*The COLLINS series is a member of the coarse-silty, mixed, acid, thermic family of Aquic Udifluvents. Evident bedding planes are characteristic. The series is a moderately well-drained soil formed in silty alluvium on slopes of 0 to 2 percent. The surface layer is brown silt loam. Underlying soil is brown silt loam with gray mottles at about 16 inches' depth. Occurs principally in the bottoms of the Silty Uplands soil area (MLRA-134)*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	5.3	5.2	5.2	5.2
Phosphorus, extractable	p/m	12	14	14	14
Potassium, extractable	p/m	74	59	48	67
Sodium, extractable	p/m	66	62	56	74
Soluble salts	mmho/cm	20	13	13	23
Organic matter	%/wt	1.49	0.93	0.63	0.79
Cation exchange capacity	me/100 g	9.2	8.5	7.4	7.8
Exchangeable calcium	me/100 g	4.13	3.49	2.92	3.05
Exchangeable magnesium	me/100 g	1.66	1.56	1.42	1.62
Ca:Mg ratio		2.52	2.22	1.97	1.77
Base saturation	%	64.8	63.4	61.5	62.4
Sand	%/wt	18	14	14	13
Silt	%/wt	68	72	74	72
Clay	%/wt	13	14	12	15
Bulk density	g/cc	1.14	1.19	1.23	1.25
Moisture equivalent	%/vol	26	26	24	28
60-cm moisture	%/vol	34	37	39	39
15-bar moisture	%/vol	9	9	7	10
Usable water after drainage	%/vol	25	28	32	29
Total porosity	%/vol	57	55	54	53
Pore volume for potential drainage and aeration	%/vol	23	18	15	14

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green and white	A+	1	100- 80	89	94
Baldcypress	C	2	95- 75		
Basswood, American	C	2	95- 75		
Beech, American	C				
Birch, river	C	2	85- 65		
Cherry, black	C	2	95- 75		
Cottonwood, eastern	A	1	125-105	120	108
Cucumbertree	C				
Dogwood, flowering	C				
Elms (except cedar)	B+	1	90- 70		
Hackberry and sugarberry	C	1	100- 80		
Hickories (except water)	C+	1	100- 80		
Holly, American	C				
Honeylocust	C	2	85- 65		
Hophornbeam, eastern	D				
Hornbeam, American	D				
Locust, black	C				
Magnolia, southern	C				
Maple, red	C	1-2	95- 75		
Mulberry	C				
Oak, cherrybark	B+	1	120-100	113	108
Oak, laurel		(2)	100- 80		
Oak, Nuttall	A	1-2	115- 95	111	107
Oak, overcup		(1)	100- 80		
Oak, Shumard	A	1-2	115- 95	100	
Oak, southern red	C				
Oak, swamp chestnut	B	1-2	100- 80	81	
Oak, water	B+	1	115- 95	108	104
Oak, white	B	1	105- 85		
Oak, willow	B	1	110- 90		103
Pecan	C	1	110- 90		
Persimmon, common	C	2	85- 65		
Pine, spruce	C				
Redbud	D				
Redcedar, eastern	C				
Sassafras	C	2	95- 75		
Sweetgum	A+	1	115- 95	108	
Sycamore, American	A	1	120-100	114	
Tupelo, black	C	2	85- 65		
Tupelo, water		(2)	90- 70		
Walnut, black	B	2	95- 75		
Willow, black		(2)	90- 70		
Yellow-poplar	A	1	120-100	118	

Table 12.—*The COMMERCE series is a member of the fine-silty, mixed, nonacid, thermic family of Aeric Fluvaquents. These soils are somewhat poorly drained and have a dark grayish-brown silt loam or silty clay loam surface and grayish-brown subsoil of the same textural class. They have developed from Mississippi River sediments (MLRA-131). Generally, they occur at high local elevations, on slopes that range from 0 to 5 percent, but some occur in ridge and swale patterns with short irregular slopes. If surface layers are above pH 7.5, it should be considered unsuitable for planting oaks*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	6.9	7.0	7.4	7.5
Phosphorus, extractable	p/m	26	18	14	15
Potassium, extractable	p/m	219	151	116	118
Sodium, extractable	p/m	22	30	28	30
Soluble salts	mmho/cm	13	9	13	16
Organic matter	%/wt	2.67	1.46	1.13	1.08
Cation exchange capacity	me/100 g	25.5	21.0	13.5	12.0
Exchangeable calcium	me/100 g	16.5	15.0	10.2	8.5
Exchangeable magnesium	me/100 g	6.5	5.2	2.8	3.0
Ca:Mg ratio		2.53	2.88	3.64	2.83
Base saturation	%	95	100	100	100
Sand	%/wt	20	19	26	24
Silt	%/wt	43	48	48	49
Clay	%/wt	37	33	26	26
Bulk density	g/cc	1.22	1.31	1.33	1.36
Moisture equivalent	%/vol	37	37	32	33
60-cm moisture	%/vol	42	42	40	42
15-bar moisture	%/vol	19	18	16	17
Usable water after drainage	%/vol	23	24	24	25
Total porosity	%/vol	54	51	50	49
Pore volume for potential drainage and aeration	%/vol	12	9	10	7

Table 12a.—*Species suitability and productivity on COMMERCE soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green	A	1-2	95-75	80	92
Baldcypress	B	1-2	110- 90		
Boxelder	C+				
Catalpa	C				
Chinaberry	C				
Cottonwood, eastern	A+	1	125-105	105	105
Dogwood, roughleaf	D				
Elms, American and slippery	C+	1	95- 75	80	
Hackberry and sugarberry	B+	1	100- 80	89	
Hawthorn	D				
Hickories		(3)	80- 60		
Honeylocust	C	1	95- 75	80	
Locust, black	C				
Maple, red and silver	B	2	90- 70		
Mulberry	C				
Oak, cherrybark	C	2	110- 90		
Oak, Nuttall	C	2	105- 85		103
Oak, overcup		(2)	85- 65		
Oak, Shumard		(2)	110- 90		
Oak, water	C	2	105- 85	104	104
Oak, swamp chestnut		(2)	95- 75		
Oak, willow	C	2	105- 85		
Osage-orange	C				
Pawpaw	D				
Pecan	B+	1	115- 95	102	
Persimmon, common	C	1-2	85- 65	70	
Sassafras	C	3	90-70		
Swamp-privet	D				
Sweetgum	A+	1	120-100	105	
Sycamore, American	A+	1	120-100	108	
Tupelo, water	C	3	80- 60		
Walnut, black	B	2	95- 75		
Willow, black	B	2	90- 70		
Yellow-poplar		(2)	100- 80		

Table 13.—*The CONVENT series is a member of the coarse-silty, mixed, nonacid, thermic family of Aeric Fluvaquents. These somewhat poorly drained soils occur on slopes of 0 to 5 percent within the Mississippi River floodplain (MLRA-131). If surface layers are above pH 7.5, it should be considered unsuitable for planting oaks*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	7.1	7.1	7.2	7.4
Phosphorus, extractable	p/m	14	7	9	6
Potassium, extractable	p/m	196	116	84	100
Sodium, extractable	p/m	124	112	104	108
Soluble salts	mmho/cm	45	34	34	40
Organic matter	%/wt	1.74	.80	.40	.60
Cation exchange capacity	me/100 g	15.3	11.2	8.9	10.3
Exchangeable calcium	me/100 g	11.10	8.63	7.35	9.60
Exchangeable magnesium	me/100 g	3.87	3.93	3.14	3.20
Ca:Mg ratio		2.87	2.20	2.34	3.00
Base saturation	%	100	100	100	100
Sand	%/wt	35	41	51	39
Silt	%/wt	47	45	41	49
Clay	%/wt	18	14	8	12
Bulk density	g/cc	1.16	1.25	1.29	1.26
Moisture equivalent	%/vol	24	21	17	20
60-cm moisture	%/vol	37	38	27	32
15-bar moisture	%/vol	13	10	8	9
Usable water after drainage	%/vol	24	28	19	23
Total porosity	%/vol	56	53	51	52
Pore volume for potential drainage and aeration	%/vol	19	15	24	20

Table 13a.—*Species suitability and productivity on CONVENT soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green	A+	1-2	95- 75		95
Baldcypress		(1-2)	110- 90		
Birch, river		(2)	85- 65		
Boxelder	C+				
Catalpa	C				
Chinaberry	C				
Cottonwood, eastern	A+	1	125-105		108
Dogwood, roughleaf	D				
Elms, American and slippery	C+	1	90- 70		
Hackberry and sugarberry	B+	1	100- 80		
Hawthorn	D				
Hickories		(3)	80- 60		
Honeylocust		(1)	95- 75		
Locust, black	C				
Maple, red and silver	B	2	90- 70		
Mulberry	C				
Oak, cherrybark	C	2-3	110- 90		110
Oak, Nuttall	C	2	110- 90		108
Oak, Shumard		(2)	110- 90		
Oak, swamp chestnut		(2)	95- 75		
Oak, water	C	2-3	105- 85		105
Oak, willow	C	2-3	105- 85		104
Osage-orange	C				
Pecan	B+	1	115- 95		
Persimmon, common	C	2	85- 65		
Sassafras	C	2	95- 75		
Swamp-privet	D				
Sweetgum	A+	1	120-100	110	
Sycamore, American	A+	1	130-110	118	
Walnut, black	C	2	95- 75		
Willow, black		(2)	90- 70		
Yellow-poplar		(2)	100- 80		

Table 14.—*The DESHA series is a member of the very fine, mixed, thermic family of Vertic Hapludolls. These somewhat poorly drained nonacid soils occur mainly in backswamp areas of the Mississippi Valley (MLRA-131). They resemble Buxin soils but have more than 60 percent clay in the control section. If surface layers are above pH 7.5, it should be considered unsuitable for planting oaks*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	6.4	7.2	6.9	6.8
Phosphorus, extractable	p/m	13	4	10	7
Potassium, extractable	p m	372	312	300	228
Sodium, extractable	p/m	256	552	800	700
Soluble salts	mmho/cm	65	191	450	572
Organic matter	%/wt	2.01	.74	.67	.60
Cation exchange capacity	me/100 g	39.7	36.3	34.7	31.2
Exchangeable calcium	me/100 g	21.75	34.72	22.35	17.18
Exchangeable magnesium	me/100 g	12.73	11.41	12.55	12.74
Ca:Mg ratio		1.71	3.04	1.78	1.35
Base saturation	%	90.2	100	100	99.7
Sand	%/wt	2	2	5	10
Silt	%/wt	19	24	27	38
Clay	%/wt	79	74	68	52
Bulk density	g/cc				
Moisture equivalent	%/vol	48	42	39	34
60-cm moisture	%/vol				
15-bar moisture	%/vol	26.0	24.5	23.2	19.9
Usable water after drainage	%/vol				
Total porosity	%/vol				
Pore volume for potential drainage and aeration	%/vol				

Table 14a.—*Species suitability and productivity on DESHA soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green	A+	3	80- 60	70	
Baldcypress	C	2	95- 75		
Cottonwood, eastern	A	2-3	100- 80		
Dogwood, roughleaf	D				
Elms, American, cedar, and slippery	C+	3	70- 50		
Hackberry and sugarberry	C	3	75- 55		
Hickory, water	C+	3	75- 55		
Honeylocust	C+	2	85- 65	71	
Maple, red	C	3	85- 65		
Mulberry	C				
Oak, cherrybark	C	3	85- 65		
Oak, Nuttall	C	3	90- 70	70	
Oak, overcup	C	2-3	80- 60	68	
Oak, Shumard		(3)	95- 75		
Oak, water	C	3	85- 65		
Oak, willow	C	3	85- 65		
Osage-orange	C				
Pecan	B	3	90- 70	72	
Persimmon, common	C	3	75- 55		
Planertree	D				
Swamp-privet	D				
Sweetgum	A	3	90- 70		
Sycamore, American	A	3	95- 75		
Willow, black	C	2	90- 70		
Yellow-poplar		(4)	<65		

Table 15.—*The DUNDEE series is a member of the fine-silty, mixed, thermic family of Aeric Ochraqualfs. These soils have a dark grayish-brown loam surface and a dark grayish-brown clay loam subsoil mottled with gray. They are somewhat poorly drained and occur on 0- to 5-percent slopes on natural levees and low terraces in Mississippi River Alluvium (MLRA-131)*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	5.0	5.0	5.2	5.3
Phosphorus, extractable	p/m	23	23	29	33
Potassium, extractable	p/m	151	128	118	95
Sodium, extractable	p/m	38	48	49	61
Soluble salts	mmho/cm	13	10	9	17
Organic matter	%/wt	1.82	0.79	0.57	0.49
Cation exchange capacity	me/100 g	17.0	23.8	23.4	19.8
Exchangeable calcium	me/100 g	7.12	11.92	12.75	11.55
Exchangeable magnesium	me/100 g	2.68	5.06	5.54	5.09
Ca:Mg ratio		2.72	2.40	2.32	2.27
Base saturation	%	60.8	74.8	81.6	88.0
Sand	%/wt	23	22	25	30
Silt	%/wt	43	44	45	45
Clay	%/wt	33	34	30	25
Bulk density	g/cc	1.24	1.34	1.39	1.41
Moisture equivalent	%/vol	36	39	39	37
60-cm moisture	%/vol	43	44	42	42
15-bar moisture	%/vol	18	21	20	17
Usable water after drainage	%/vol	25	23	22	25
Total porosity	%/vol	53	50	48	47
Pore volume for potential drainage and aeration	%/vol	10	6	6	5

Table 15a.—*Species suitability and productivity on DUNDEE soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green	A	2	90- 70	72	84
Basswood, American	C	2	95- 75		
Birch, river	C	3	80- 60		
Boxelder	C				
Catalpa	C				
Cherry, black		(1-2)	100- 80		
Chinaberry	C				
Cottonwood, eastern	A	2	110- 90		96
Dogwood, flowering and roughleaf	D				
Elms	C+	1-2	90- 70	77	
Hackberry and sugarberry	C	2	90- 70		
Hawthorn	D				
Hickories	C+	1	100- 80		
Honeylocust	C	1-2	90- 70	82	
Hophornbeam, eastern	D				
Hornbeam, American	D				
Locust, black	C				
Maple, red	C	2	90- 70	76	
Mulberry	C				
Oak, cherrybark	B+	2	110- 90	96	100
Oak, Nuttall	A+	2	105- 85	97	96
Oak, laurel		(2)	100- 80		
Oak, overcup	C	2	85- 65		
Oak, Shumard	A	2	105- 85	96	
Oak, swamp chestnut	B	2	90- 70	80	
Oak, swamp post	C				
Oak, water	B+	2	105- 85	97	97
Oak, white		(2)	100- 80		
Oak, willow	B+	1-2	110- 90	100	97
Pawpaw	D				
Prickly-ash	D				
Pecan	B	2	100- 80	94	
Persimmon, common	C	2	85- 65	75	
Redbud	D				
Sassafras	C	2	95- 75		
Swamp-privet	D				
Sweetgum	A+	2	110- 90	97	
Sycamore	A	2	115- 95	106	
Tupelo, black	C	2	90- 70	82	
Tupelo, water		(2)	90- 70		
Walnut, black	B	3	90- 70		
Yellow-poplar		(2)	100- 80		

Table 16.—*The FALAYA series is a member of the coarse-silty, mixed, acid, thermic family of Aeric Fluvaquents. These somewhat poorly drained soils occur on slopes of 0 to 2 percent within the Silty Uplands (MLRA-134)*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	5.3	5.2	5.1	5.1
Phosphorus, extractable	p/m	12	14	7	5
Potassium, extractable	p/m	59	34	24	24
Sodium, extractable	p/m	48	28	26	44
Soluble salts	mmho/cm	12	7	8	8
Organic matter	%/wt	1.65	1.10	.58	.55
Cation exchange capacity	me/100 g	14.2	8.7	5.3	5.5
Exchangeable calcium	me/100 g	5.18	1.95	0.71	0.35
Exchangeable magnesium	me/100 g	2.48	0.89	0.32	0.20
Ca:Mg ratio		2.09	2.19	2.22	1.75
Base saturation	%	56.3	34.5	22.6	14.5
Sand	%/wt	15	15	14	16
Silt	%/wt	56	64	72	70
Clay	%/wt	29	21	14	14
Bulk density	g/cc	1.12	1.32	1.36	1.28
Moisture equivalent	%/vol	32	34	31	28
60-cm moisture	%/vol	40	44	40	36
15-bar moisture	%/vol	14	12	7	7
Usable water after drainage	%/vo	26	32	33	29
Total porosity	%/vol	58	50	49	52
Pore volume for potential drainage and aeration	%/vol	18	6	9	16

Table 16a.—*Species suitability and productivity on FALAYA soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green and white	A+	1	105- 85		95
Baldcypress	C	2	95- 75		
Basswood, American		(2)	95- 75		
Beech, American	C				
Birch, river		(2)	85- 65		
Buckeye	D				
Buttonbush, common	D				
Cherry, black	C	2	95- 75		
Cottonwood, eastern	A	1-2	120-100		110
Elms	C+	2	75- 55		
Hackberry and sugarberry	C	2	90- 70		
Hawthorn	D				
Hickories	C	2	90- 70		
Holly, American	C				
Honeylocust	C	1	95- 75		
Hophornbeam, eastern	D				
Hornbeam, American	D				
Locust, black	C				
Magnolia, southern	C				
Maple, red	C	2	90- 70		
Mulberry	C				
Oak, cherrybark	B+	1-2	115- 95	108	111
Oak, laurel	B	2	100- 80		
Oak, Nuttall	A	1	115- 95	109	109
Oak, overcup	C	1	100- 80		
Oak, pin	C				
Oak, Shumard	A	2	110- 90		
Oak, swamp chestnut	B	1	110- 90		
Oak, water	B+	1	110- 90	101	107
Oak, white	B	2	100- 80		
Oak, willow	B	1	110- 90	104	104
Pecan		(2)	100- 80		
Persimmon, common	C	2	85- 65		
Pine, spruce	C				
Prickly-ash	D				
Redcedar, eastern	C				
Sassafras		(1-2)	100- 80		
Swamp-privet	D				
Sweetgum	A+	1-2	115- 95	111	
Sycamore, American	A	1-2	120-100		
Tupelo, black	C	2	85- 65		
Tupelo, water		(2)	90- 70		
Walnut, black	C	3	90- 70		
Willow, black	C	2	90- 70		
Yellow-poplar	A	1-2	115- 95		

Table 17.—*The FORESTDALE series is a member of the fine, montmorillonitic, thermic family of Typic Ochraqualfs. This soil has a thin dark grayish-brown silty clay loam surface layer overlying subsoil of light gray silty clay, mottled with yellowish brown. It is poorly drained, strongly acid, and occurs in fine- to moderately fine-textured Mississippi River alluvium (MLRA-131) on slopes of 0 to 3 percent*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	5.2	5.0	5.1	5.5
Phosphorus, extractable	p/m	27	28	33	33
Potassium, extractable	p/m	184	186	170	139
Sodium, extractable	p/m	38	64	100	99
Soluble salts	mmho/cm	11	7	17	39
Organic matter	%/wt	2.32	0.92	0.61	0.59
Cation exchange capacity	me/100 g	24.9	33.2	30.4	24.4
Exchangeable calcium	me/100 g	10.09	14.59	15.24	13.30
Exchangeable magnesium	me/100 g	4.26	6.45	6.64	5.62
Ca:Mg ratio		2.42	2.27	2.30	2.34
Base saturation	%	62.0	66.3	75.9	82.3
Sand	%/wt	16	13	17	22
Silt	%/wt	38	35	38	43
Clay	%/wt	46	52	45	35
Bulk density	g/cc	1.24	1.29	1.37	1.42
Moisture equivalent	%/vol	42	46	46	43
60-cm moisture	%/vol	45	51	47	44
15-bar moisture	%/vol	23	27	27	24
Usable water after drainage	%/vol	22	24	20	20
Total porosity	%/vol	53	51	48	46
Pore volume for potential drainage and aeration	%/vol	8	0	1	2

Table 17a.—*Species suitability and productivity on FORESTDALE soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green	A+	2	90- 70		83
Baldcypress	C	2	95- 75		
Basswood, American	C	2	95- 75		
Buttonbush	D				
Cottonwood, eastern	A	2-3	105- 85		93
Cottonwood, swamp	C				
Dogwood, roughleaf	D				
Elms, American and slippery	C+	2-3	75- 55	65	
Elm, cedar	C				
Elm, winged	C				
Hackberry and sugarberry	C+	2-3	85- 65	75	
Hawthorn	D				
Hickories	B+	2	90- 70	81	
Honeylocust	C	1	95- 75		
Hophornbeam, eastern	D				
Hornbeam, American	D				
Maple, red	C	3	85- 65	70	
Mulberry	C				
Oak, cherrybark	B+	2	105- 85	97	98
Oak, laurel	B	2	100- 80		
Oak, Nuttall	A+	2	100- 80	89	94
Oak, overcup	B+	1-2	95- 75	82	
Oak, Shumard	B	2-3	95- 75		
Oak, swamp chestnut	B	2	95- 75	83	
Oak, swamp post	C				
Oak, water	B+	2	100- 80	90	93
Oak, white		(2)	100- 80	80	
Oak, willow	B+	2	100- 80	94	93
Pawpaw	D				
Pecan	B	2-3	90- 70	85	
Persimmon, common	C	2	85- 65		
Planertree	D				
Prickly-ash	D				
Redbud	D				
Sassafras	C	3	90- 70		
Sumac, smooth	D				
Swamp-privet	D				
Sweetgum	A+	2	105- 85	94	
Sycamore, American	A	2-3	105- 85	100	
Tupelo, black	C	2	85- 65		
Tupelo, water	A	2	90- 70		
Willow, black	C	2	90- 70		
Yellow-poplar	C	3	85- 65		

Table 18.—*The GILLSBURG series is a member of the coarse-silty, mixed, acid, thermic family of the Aeric Fluvaquents. These somewhat poorly drained soils occur mainly on slopes of 0 to 2 percent in stream bottoms and low terraces within the Coastal Plains (MLRA-133) and Silty Uplands (MLRA-134)*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	5.6	5.3	5.2	5.5
Phosphorus, extractable	p/m	13	3	3	8
Potassium, extractable	p/m	70	80	30	37
Sodium, extractable	p/m	48	52	64	124
Soluble salts	mmho/cm	23	16	24	15
Organic matter	% wt	1.33	.32	.25	.32
Cation exchange capacity	me 100 g	8.0	5.5	3.8	5.5
Exchangeable calcium	me/100 g	2.54	1.23	0.65	0.63
Exchangeable magnesium	me/100 g	1.20	1.03	0.52	0.91
Ca:Mg ratio		2.12	1.19	1.25	0.69
Base saturation	%	50.0	45.5	34.2	32.7
Sand	%/wt	15	17	21	23
Silt	%/wt	67	67	69	63
Clay	%/wt	18	16	10	14
Bulk density	g/cc				
Moisture equivalent	%/vol				
60-cm moisture	%/vol				
15-bar moisture	%/vol				
Usable water after drainage	%/vol				
Total porosity	%/vol				
Pore volume for potential drainage and aeration	%/vol				

Table 18a.—*Species suitability and productivity on GILLSBURG soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green and white	A+	1-2	95- 75	75	84
Baldcypress	C	2	95- 75		
Basswood, American		(1-2)	100- 80		
Beech, American	C				
Birch, river		(1-2)	90- 70		
Cherry, black	C	2	95- 75		
Cottonwood, eastern	A	2	115- 95		95
Dogwood, flowering	C				
Elms	C+	2	75- 55		
Hackberry and sugarberry	C	2	90- 70		
Hickories (except water)	C	1	95- 75		
Honeylocust	C	2	85- 65		
Hophornbeam, eastern	D				
Hornbeam, American	D				
Locust, black	C				
Magnolia, southern	C				
Maple, red	C	2	90- 70		
Mulberry	C				
Oak, cherrybark	B+	1-2	115- 95	104	99
Oak, laurel		(2)	100- 80		
Oak, Nuttall	A	1	115- 95		94
Oak, overcup	C	2	85- 65		
Oak, Shumard	A	2	110- 90		
Oak, swamp chestnut	B	1	110- 90		
Oak, water	B+	1	115- 95		94
Oak, white	B	1-2	100- 80	85	
Oak, willow	B	1	110- 90		96
Pecan		(2)	100- 80		
Persimmon, common	C	2	85- 65		
Pine, spruce	C				
Prickly-ash	D				
Redbud	D				
Redcedar, eastern	C				
Sassafras	C	2	95- 75		
Swamp-privet	D				
Sweetgum	A+	1-2	110- 90	95	
Sycamore, American	A	2	115- 95		
Tupelo, black	C	2	85- 65		
Tupelo, water		(2)	90- 70		
Willow, black	C	2	90- 70		
Yellow-poplar	A	1-2	115- 95		

Table 19.—*The IUKA series is a member of the coarse-loamy, siliceous, acid, thermic family of Aquic Udifluvents. These moderately well-drained nearly level soils occur on floodplains within the Coastal Plains (MLRA-133)*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	4.9	5.1	5.3	5.2
Phosphorus, extractable	p/m	4	3	4	3
Potassium, extractable	p/m	52	36	34	29
Sodium, extractable	p/m	42	58	50	53
Soluble salts	mmho/cm	15	10	10	10
Organic matter	% wt	1.51	.93	.61	.62
Cation exchange capacity	me/100 g	5.0	5.6	5.9	6.0
Exchangeable calcium	me/100 g	1.69	2.03	1.92	1.54
Exchangeable magnesium	me/100 g	0.91	0.76	0.82	0.80
Ca:Mg ratio		2.14	3.95	2.51	1.97
Base saturation	%	53.5	53.0	50.0	44.6
Sand	%/wt	32	39	47	48
Silt	%/wt	51	47	40	39
Clay	%/wt	17	14	12	13
Bulk density	g/cc	1.32	1.44	1.50	1.52
Moisture equivalent	%/vol	28	27	21	27
60-cm moisture	%/vol	34	38	33	36
15-bar moisture	%/vol	10	8	7	8
Usable water after drainage	%/vol	24	30	26	28
Total porosity	%/vol	50	46	43	43
Pore volume for potential drainage and aeration	%/vol	16	8	10	7

Table 19a.—*Species suitability and productivity on IUKA soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green and white	A	2	95- 75	90	88
Baldcypress	C	3	85- 65		
Basswood, American	C	2	95- 75		
Beech, American	D				
Birch, river	C	2	85- 65		
Boxelder	D				
Buckeye	D				
Cherry, black	C	2	95- 75		
Chinaberry	D				
Cottonwood, eastern	C	2-3	100- 80	96	100
Dogwood, flowering	C				
Elms	C	1	95- 75	94	
Hackberry and sugarberry	C	2-3	85- 65	74	
Hawthorn	D				
Hickories (except water)	B+	1	95- 75		
Holly, American	C				
Honeylocust		(3)	80- 60		
Hophornbeam, eastern	D				
Hornbeam, American	D				
Magnolia, southern	C				
Maple, red	B+	2	90- 70	78	
Mulberry	C				
Oak, cherrybark	B+	1-2	115- 95	101	105
Oak, laurel		(2)	100- 80		
Oak, Nuttall		(2)	110- 90		
Oak, overcup		(3)	80- 60		
Oak, Shumard		(2)	110- 90		
Oak, southern red	C				
Oak, swamp chestnut	B	1-2	100- 80		
Oak, water	B+	2	105- 85	95	100
Oak, white	B	1-2	100- 80	91	
Oak, willow	B	2	105- 85	97	99
Pecan		(2)	100- 80		
Persimmon, common	C	3	75- 55		
Pine, spruce	B				
Prickly-ash	D				
Sassafras	B	1-2	100- 80		
Sweetbay	D				
Sweetgum	A+	1-2	110- 90	102	
Sycamore, American	A	1-2	115- 95	104	
Tupelo, black	B+	1-2	90- 70	76	
Walnut, black		(2)	95- 75		
Yellow-poplar	A	1-2	115- 95	105	

Table 20.—*The JENA series is a member of the coarse-loamy, siliceous, thermic family of Fluventic Dystrochrepts. These acid, well-drained soils occur on slopes of 0 to 3 percent in bottoms within the Coastal Plains (MLRA-133)*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	4.9	4.7	4.6	4.7
Phosphorus, extractable	p/m	4	4	2	3
Potassium, extractable	p/m	92	50	45	34
Sodium, extractable	p/m	20	18	15	18
Soluble salts	mmho/cm	14	8	5	7
Organic matter	%/wt	2.41	.62	.42	.32
Cation exchange capacity	me/100 g	9.2	7.9	8.2	6.3
Exchangeable calcium	me/100 g	1.42	0.49	0.30	0.30
Exchangeable magnesium	me/100 g	0.68	0.44	0.32	0.20
Ca:Mg ratio		2.09	1.11	0.94	1.50
Base saturation	%	26.1	15.2	11.0	11.1
Sand	%/wt	37	39	43	57
Silt	%/wt	45	43	39	27
Clay	%/wt	18	18	18	16
Bulk density	g/cc	1.38	1.58	1.59	1.59
Moisture equivalent	%/vol	33	32	30	24
60-cm moisture	%/vol	38	36	35	30
15-bar moisture	%/vol	11	12	12	10
Usable water after drainage	%/vol	27	24	23	20
Total porosity	%/vol	48	40	40	40
Pore volume for potential drainage and aeration	%/vol	10	4	5	10

Table 20a. -*Species suitability and productivity on JENA soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green and white	C	3	75- 55		
Baldcypress	C	3	85- 65		
Basswood, American	B	2	95- 75	80	
Birch, river	C	2	85- 65		
Cherry, black	B	2	95- 75		
Chinaberry	D				
Cottonwood, eastern	C	3	100- 80		
Dogwood, flowering	C				
Elms	C	2	75- 55		
Hackberry		(2)	90- 70		
Hickories (except water)	B	1	95- 75		
Holly, American	C				
Honeylocust		(2)	85- 65		
Hophornbeam, eastern	D				
Hornbeam, American	D				
Locust, black	C				
Magnolia, southern	C				
Maple, red	C	2	90- 70		
Oak, cherrybark	B+	1-2	105- 85	87	99
Oak, laurel		(2)	100- 80		
Oak, Nuttall		(2)	110- 90		
Oak, overcup		(3)	80- 60		
Oak, Shumard	A	2	110- 90		
Oak, southern red	C				
Oak, swamp chestnut		(2)	95- 75		
Oak, water	B	2	100- 80	82	94
Oak, white	B	1-2	100- 80		
Oak, willow	B	2	100- 80		96
Pecan		(2)	100- 80		
Sassafras	C	1-2	100- 80		
Sweetbay	D				
Sweetgum	A+	1-2	110- 90	95	
Sycamore, American	A	2	110- 90		
Tupelo, black	B	2	85- 65		
Walnut, black		(2)	95- 75		
Yellow-poplar	A	1-2	115- 95		

Table 21.—*The JOHNSTON series is a member of the coarse-loamy, siliceous, acid, thermic family of Cumulic Humaquepts. These level, poorly drained soils occur on bottoms in the Coastal Plains (MLRA-133). The pedon used to determine the soil properties had less organic matter than the standard description of the soil gives, but species suitability and management needs are similar. If waterlogged for one or more growing seasons, it is not suitable for hardwoods. There should be no free water in the surface foot of soil during July, August, and September to obtain productivity within the estimated range*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	4.9	4.9	4.7	4.6
Phosphorus, extractable	p/m	6	9	5	1
Potassium, extractable	p/m	20	40	20	32
Sodium, extractable	p/m	64	64	68	64
Soluble salts	mmho/cm	21	24	17	12
Organic matter	% wt	3.15	3.35	2.88	.80
Cation exchange capacity	me/100 g	8.5	7.4	8.5	6.1
Exchangeable calcium	me/100 g	0.87	0.68	0.42	0.45
Exchangeable magnesium	me/100 g	0.30	0.22	0.22	0.32
Ca:Mg ratio		2.90	3.09	1.91	1.41
Base saturation	%	15.3	13.5	8.2	14.8
Sand	% wt	49	52	45	44
Silt	%/wt	35	36	35	26
Clay	%/wt	14	10	18	30
Bulk density	g/cc	1.38	1.34	1.36	1.56
Moisture equivalent	%/vol	32	28	31	33
60-cm moisture	%/vol	35	38	37	35
15-bar moisture	%/vol	14	12	15	19
Usable water after drainage	%/vol	21	26	22	16
Total porosity	%/vol	48	50	49	41
Pore volume for potential drainage and aeration	%/vol	13	12	12	6

Table 21a.—*Species suitability and productivity on JOHNSTON soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green and white	A	1-2	100- 80		
Baldcypress	B	2	95- 75		
Birch, river		(2)	85- 65		
Buttonbush	D				
Cottonwood		(3)	100- 80		
Dogwood, roughleaf	D				
Elm, American	C	2	75- 55		
Hackberry		(2)	90- 70		
Hawthorn	D				
Hickory, water		(3)	80- 60		
Holly, American	D				
Honeylocust		(2)	85- 65		
Maple, red	B	2	90- 70		
Magnolia, southern	C				
Oak, cherrybark		(2)	110- 90		
Oak, laurel	B	2	100- 80		
Oak, Nuttall		(2)	110- 90		
Oak, overcup	B	2	85- 65		
Oak, swamp chestnut	B	2	100- 80	96	
Oak, water	B+	2	105- 85	103	107
Oak, willow		(3)	85- 65		
Persimmon, common	B	2	85- 65		
Poison-sumac	D				
Planertree	D				
Sweetbay	C+				
Sweetgum	A+	2	110- 90	111	
Sweetleaf, common	C+				
Sycamore, American	B	3	90- 70		
Tupelo, swamp	B+	2	85- 65		
Tupelo, water	A	2	90- 70		
Willow, black	B	2	90- 70		
Yaupon	D				
Yellow-poplar	A+	1-2	115- 95	115	

Table 22.—*The KINSTON series is a member of the fine-loamy, siliceous, acid, thermic family of Typic Fluvaquents. These nearly level, poorly drained soils occur in the Coastal Plains (MLRA-133)*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	4.6	4.6	4.7	4.7
Phosphorus, extractable	p/m	7	4	4	4
Potassium, extractable	p/m	60	52	62	44
Sodium, extractable	p/m	56	64	64	64
Soluble salts	mmho/cm	26	16	12	15
Organic matter	%/wt	2.62	.60	.34	.27
Cation exchange capacity	me/100 g	13.5	11.4	11.2	9.9
Exchangeable calcium	me/100 g	2.12	0.65	0.53	0.33
Exchangeable magnesium	me/100 g	0.79	0.44	0.49	0.49
Ca:Mg ratio		2.68	1.48	1.09	0.67
Base saturation	%	23.7	12.3	11.6	11.1
Sand	%/wt	20	16	25	34
Silt	%/wt	51	58	49	42
Clay	%/wt	29	26	26	24
Bulk density	g/cc	.97	1.41	1.38	1.53
Moisture equivalent	%/vol	27	37	33	32
60-cm moisture	%/vol	36	39	36	35
15-bar moisture	%/vol	13	16	14	14
Usable water after drainage	%/vol	23	23	22	21
Total porosity	%/vol	63	47	48	42
Pore volume for potential drainage and aeration	%/vol	27	8	12	7

Table 22a.—*Species suitability and productivity on KINSTON soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green and white	A+	1	100- 80	90	96
Baldcypress	B	2	95- 75		
Basswood, American	C	3	90- 70		
Birch, river		(2)	85- 65		
Cherry, black	C	3	90- 70		
Cottonwood		(3)	100- 80		
Elms	C+	2	75- 55		
Hackberry		(3)	75- 55		
Hawthorn	D				
Hickories	C+	2	90- 70		
Holly, American	D				
Honeylocust		(2)	85- 65		
Hophornbeam, eastern	D				
Hornbeam, American	D				
Maple, red	C	2	90- 70		
Oak, cherrybark	B+	2	115- 95	107	112
Oak, laurel		(2)	100- 80		
Oak, Nuttall	A	1-2	115- 95	111	109
Oak, overcup	B	1	100- 80		
Oak, Shumard		(2)	110- 90		
Oak, swamp chestnut	B	1	105- 85	95	
Oak, water	B+	1-2	110- 90		107
Oak, white	B	1-2	100- 80	86	
Oak, willow	B	2	105- 85		104
Pecan		(3)	90- 70		
Persimmon, common	C	2	85- 65		
Sassafras	C	3	90- 70		
Sweetgum	A+	1-2	115- 95	111	
Sycamore, American	B	2-3	105- 85		
Tupelo, black		(1-2)	90- 70		
Tupelo, swamp	C				
Tupelo, water	A	2	85- 65		
Willow, black		(2)	90- 70		
Yellow-poplar	C	2	100- 80		

Table 23.—*The LEEPER series is a member of the fine, montmorillonitic, nonacid, thermic family of Vertic Haplaquepts. These somewhat poorly drained soils occur on nearly level floodplains within the Blacklands (MLRA-135). If surface layers are above pH 7.5, it should be considered unsuitable for planting oaks*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	6.0	5.8	6.2	6.8
Phosphorus, extractable	p/m	20	17	8	8
Potassium, extractable	p m	159	158	161	164
Sodium, extractable	p m	84	164	260	288
Soluble salts	mmho/cm	39	30	51	68
Organic matter	%/wt	2.50	1.40	1.00	0.82
Cation exchange capacity	me/100 g	29	30	31	32
Exchangeable calcium	me/100 g	24.9	25.8	28.0	30.0
Exchangeable magnesium	me/100 g	1.5	1.5	1.4	1.2
Ca:Mg ratio		17.7	19.6	23.9	30.4
Base saturation	%	92	93	97	96
Sand	% wt	24	21	20	18
Silt	%/wt	35	32	30	32
Clay	%/wt	40	47	50	50
Bulk density	g/cc	1.05	1.08	1.10	1.20
Moisture equivalent	%/vol	36	38	40	43
60-cm moisture	%/vol	42	45	45	45
15-bar moisture	%/vol	20	22	23	24
Usable water after drainage	%/vol	22	23	22	21
Total porosity	%/vol	60	59	58	55
Pore volume for potential drainage and aeration	%/vol	18	14	13	10

Table 23a.—*Species suitability and productivity on LEEPER soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green	A+	1	100- 80	88	78
Baldcypress	C	3	85- 65		
Cherry, black	B	2	95- 75		
Cottonwood, eastern	A	2	115- 95		
Dogwood, roughleaf	D				
Elms	B	2	75- 55		
Hackberry and sugarberry	B+	1	95- 75	84	
Hickories (except water)	C	2	90- 70		
Honeylocust	C	1	95- 75		
Locust, black	B				
Maple, red	C	2	90- 70		
Oak, cherrybark	B	2	105- 85	98	92
Oak, Durand	B	2	100- 80	85	
Oak, Nuttall	B	2	110- 90		
Oak, overcup	C	2	85- 65		
Oak, Shumard	B	2	105- 85	93	
Oak, swamp chestnut	B	2	95- 75	86	
Oak, water	B	2	105- 85	93	
Oak, white	B	2	95- 75	92	
Oak, willow	B	2	100- 80		92
Osage-orange	C				
Pecan		(2)	100- 80		
Persimmon, common		(1-2)	85- 65		
Sweetgum	A+	2	105- 85	88	
Sycamore, American	A	2	110- 90		
Walnut, black		(2)	95- 75		
Willow, black		(2)	90- 70		
Yellow-poplar		(2)	100- 80		

Table 24.—*The LEXINGTON series is a member of the fine-silty, mixed, thermic family of Typic Paleudalfs. These well-drained acid soils occur on ridges and slopes of 2 to 17 percent within the Silty Uplands (MLRA-134). Not suitable for hardwoods when eroded. Values apply only to soils with 6 or more inches of topsoil*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	5.2	4.8	4.9	4.8
Phosphorus, extractable	p m	4	6	7	6
Potassium, extractable	p m	218	158	84	60
Sodium, extractable	p/m	11	8	18	12
Soluble salts	mmho/cm	0	0	0	0
Organic matter	%/wt	2.23	.46	.25	.25
Cation exchange capacity	me/100 g	14.0	10.7	8.3	7.0
Exchangeable calcium	me/100 g	6.03	1.83	1.32	1.08
Exchangeable magnesium	me/100 g	3.37	3.04	2.55	1.46
Ca:Mg ratio		1.79	0.60	0.52	0.74
Base saturation	%	72.1	50.5	50.6	40.0
Sand	%/wt	10	13	23	33
Silt	%/wt	65	58	53	45
Clay	%/wt	25	29	24	22
Bulk density	g/cc	1.36	1.56	1.64	1.68
Moisture equivalent	%/vol	35	39	34	32
60-cm moisture	%/vol	39	41	36	33
15-bar moisture	%/vol	15	16	13	11
Usable water after drainage	%/vol	24	25	23	22
Total porosity	%/vol	49	41	38	37
Pore volume for potential drainage and aeration	%/vol	10	0	2	4

Table 24a.—*Species suitability and productivity on LEXINGTON soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, white	C	3-4	80- 60		75
Basswood, American		(1-2)	100- 80		
Cherry, black	C	2	95- 75		
Cottonwood		(4)	<75		
Dogwood, flowering	C				
Elms, American and winged	C	3	80- 60	72	
Hackberry		(3)	75- 55		
Hickories (except water)	C+	2	90- 70		
Holly, American	D				
Honeylocust		(4)	<55		
Hophornbeam, eastern	D				
Hornbeam, American	D				
Locust, black	C				
Maple, red and sugar	C	3	85- 65		
Oak, black	C				
Oak, blackjack	D				
Oak, cherrybark	B+	2	100- 80		93
Oak, chestnut	C				
Oak, chinkapin	C				
Oak, northern red	B				
Oak, Nuttall	C	3	95- 75		89
Oak, overcup		(3)	80- 60		
Oak, post	C				
Oak, scarlet	C				
Oak, Shumard	A	2	105- 85		
Oak, southern red	C+				
Oak, swamp chestnut		(3)	85- 65		
Oak, water	C+	3	90- 70		90
Oak, white	B	2	90- 70		
Oak, willow	C	3	90- 70		91
Pecan		(3)	90- 70		
Persimmon, common	C	3	75- 55		
Redbud	D				
Redcedar, eastern	C				
Sassafras	C	3	90- 70		
Sumac, smooth	D				
Sweetgum	A+	2-3	95- 75	89	
Sycamore, American		(3)	90- 70		
Tupelo, black	C	3	80- 60		
Yellow-poplar	A	2-3	95- 75		

Table 25.—*The MANTACHIE series is a member of the fine-loamy, siliceous, acid, thermic family of Aeric Fluvaquents. These somewhat poorly drained soils occur on gently sloping floodplains within MLRA-133*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	4.6	4.5	4.5	4.5
Phosphorus, extractable	p/m	7	5	4	3
Potassium, extractable	p/m	44	36	36	44
Sodium, extractable	p/m	28	40	42	68
Soluble salts	mmho/cm	14	10	9	10
Organic matter	% wt	1.61	.60	.51	.38
Cation exchange capacity	me 100 g	10	10	11	11
Exchangeable calcium	me/100 g	1.8	1.3	1.0	1.0
Exchangeable magnesium	me/100 g	1.3	1.3	1.2	1.3
Ca:Mg ratio		1.7	1.2	1.0	0.9
Base saturation	%	34	28	24	22
Sand	%, wt	36	36	37	37
Silt	%/wt	40	38	36	33
Clay	%/wt	24	26	27	30
Bulk density	g/cc	1.24	1.40	1.39	1.39
Moisture equivalent	%/vol	30	32	32	33
60-cm moisture	%/vol	40	39	38	36
15-bar moisture	%/vol	13	14	14	14
Usable water after drainage	%/vol	27	25	24	22
Total porosity	%/vol	53	47	48	48
Pore volume for potential drainage and aeration	%/vol	13	8	10	12

Table 25a.--*Species suitability and productivity on MANTACHIE soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green and white	A+	2	90- 70	80	82
Baldcypress	C	2	95- 75		
Basswood, American	C	2	95- 75		
Birch, river		(1-2)	90- 70		
Cherry, black	C	2	95- 75		
Cottonwood, eastern	C	3	100- 80		
Dogwood, flowering	C				
Elms	C+	2	90- 70	75	
Hackberry		(2)	90- 70		
Hickories (except water)	B+	1-2	90- 70	79	
Holly, American	C+	3			
Honeylocust		(2)	85- 65		
Hophornbeam, eastern	D+				
Hornbeam, American	D+				
Magnolia, southern	C				
Maple, red	B	2	90- 70	83	
Mulberry	C				
Oak, cherrybark	B+	2	110- 90	96	97
Oak, laurel		(2)	100- 80		
Oak, Nuttall	A	2	105- 85	100	91
Oak, overcup	C	1	95- 75	78	
Oak, Shumard		(2)	110- 90		
Oak, swamp chestnut	B	2	95- 75	82	
Oak, water	B+	2	100- 80	90	92
Oak, white	B	2	90- 70	73	
Oak, willow	B	2	100- 80	88	93
Pecan		(2)	100- 80		
Persimmon, common	C	2	85- 65		
Pine, spruce	B				
Sassafras	B	1-2	100- 80		
Sweetgum	A+	2	105- 85	92	
Sycamore, American	A	2	110- 90	106	
Tupelo, black	C+	2			
Tupelo, swamp	C				
Tupelo, water	A	2	90- 70	78	
Willow, black	C	3	80- 60		
Yellow-poplar	A	2	105- 85		

Table 26.—*The MEMPHIS series is a member of the fine-silty, mixed, thermic family of Typic Hapludalfs. These well-drained acid soils have developed on ridgetops and slopes of less than 17 percent within the Silty Uplands (MLRA-134). Not suitable for hardwoods when eroded. Values apply only to soils with 6 inches or more of topsoil*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	5.3	5.3	5.3	5.3
Phosphorus, extractable	p/m	23	55	58	62
Potassium, extractable	p/m	38	54	60	60
Sodium, extractable	p/m	18	24	32	41
Soluble salts	mmho/cm	14	8	8	13
Organic matter	%/wt	1.09	.54	.38	.38
Cation exchange capacity	me/100 g	7.0	12.4	15.2	13.4
Exchangeable calcium	me/100 g	3.2	5.6	7.3	6.3
Exchangeable magnesium	me/100 g	1.1	2.2	3.0	3.0
Ca:Mg ratio		2.90	2.54	2.43	2.10
Base saturation	%	64	67	71	73
Sand	%/wt	12	11	10	11
Silt	%/wt	72	65	66	67
Clay	%/wt	16	24	24	22
Bulk density	g/cc	1.28	1.31	1.32	1.37
Moisture equivalent	%/vol	29	34	36	36
60-cm moisture	%/vol	40	40	41	41
15-bar moisture	%/vol	10	15	15	14
Usable water after drainage	%/vol	30	25	26	27
Total porosity	%/vol	52	51	50	48
Pore volume for potential drainage and aeration	%/vol	12	11	9	7

Table 26a.—*Species suitability and productivity on MEMPHIS soils with slopes of less than 17 percent*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, white	C	3	85- 65	79	80
Basswood, American	C	2	95- 75	85	
Cherry, black	C	2	95- 75		
Cottonwood, eastern	C	3	100- 80		
Dogwood, flowering	C				
Elms, American and winged	C	3	80- 60	70	
Hackberry		(3)	75- 55		
Hickories (except water)	C	2	90- 70		
Holly, American	C				
Honeylocust		(3)	80- 60		
Locust, black	C				
Maple, red and sugar	C	3	85- 65		
Oak, black	B				
Oak, blackjack	D				
Oak, cherrybark	B+	2	110- 90	100	95
Oak, chestnut	C				
Oak, chinkapin	C				
Oak, northern red	B				
Oak, Nuttall	C	3	95- 75		90
Oak, overcup		(3)	80- 60		
Oak, post	C				
Oak, scarlet	C				
Oak, Shumard	A	2	110- 90	94	
Oak, southern red	C+				
Oak, swamp chestnut		(3)	85- 65		
Oak, water	C	2-3	95- 75	88	91
Oak, white	B	2	90- 70		
Oak, willow		(3)	85- 65		
Paulownia, royal	C				
Pecan		(2)	100- 80		
Persimmon, common	C	3	75- 55		
Prickly-ash	D				
Redbud	D				
Redcedar, eastern	C				
Sassafras	C	3	85- 65	77	
Sumac, smooth	D				
Sweetgum	A+	2	100- 80	90	
Sycamore, American	C	3	95- 75		
Tupelo, black	C	2	85- 65		
Walnut, black	C	2	95- 75		
Yellow-poplar	A	2	100- 80	91	

Table 27.—*MEMPHIS soils that occur on steep slopes of greater than 17 percent within the Silty Uplands (MLRA-134). Planting is not suggested for any species on this erosive phase if normal procedures are used*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	5.2	5.0	5.2	5.4
Phosphorus, extractable	p/m	31	42	49	49
Potassium, extractable	p/m	86	68	59	56
Sodium, extractable	p/m	21	27	42	56
Soluble salts	mmho/cm	16	3	8	5
Organic matter	%/wt	1.77	.62	.46	.38
Cation exchange capacity	me/100 g				
Exchangeable calcium	me/100 g				
Exchangeable magnesium	me/100 g				
Ca:Mg ratio					
Base saturation	%				
Sand	%/wt	18	12	13	13
Silt	%/wt	68	67	68	70
Clay	%/wt	14	21	19	17
Bulk density	g/cc	1.38	1.35	1.41	1.42
Moisture equivalent	%/vol	34	36	38	37
60-cm moisture	%/vol	41	40	42	41
15-bar moisture	%/vol	11	14	15	13
Usable water after drainage	%/vol	30	26	27	28
Total porosity	%/vol	48	49	47	46
Pore volume for potential drainage and aeration	%/vol	7	9	5	5

Table 27a. —*Species suitability and productivity on MEMPHIS soils with slopes of greater than 17 percent*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green and white	B	1-2	95- 75		90
Baldcypress		(3-4)	75- 55		
Basswood, American	B	2	100- 80	90	
Beech, American	C				
Cherry, black	B	2	95- 75		
Cottonwood, eastern	B	2	115- 95		100
Cucumbertree	C				
Dogwood, flowering	C				
Elms, American, slippery, and winged	C+	2	90- 70	80	
Hackberry		(2)	90- 70		
Hickories (except water)	C	1			
Holly, American	C				
Honeylocust		(2)	85- 65		
Hophornbeam, eastern	D				
Hornbeam, American	D				
Locust, black	B				
Magnolia, southern	C				
Maple, red and sugar	C	3	85- 65		
Mulberry	C				
Oak, black	B				
Oak, cherrybark	B+	1	125-105	113	105
Oak, chinkapin	C				
Oak, northern red	B				
Oak, Nuttall	B	2	115- 95		101
Oak, overcup		(2)	85- 65		
Oak, Shumard	B	1	120-100		
Oak, southern red	B	1-2	110- 90	100	
Oak, swamp chestnut	C	2	100- 80	85	
Oak, water	B	2	105- 85	89	
Oak, white	B+	1	105- 85		
Oak, willow	B	2	105- 85		99
Paulownia, royal	C				
Pecan		(2)	100- 80		
Persimmon, common	C	3	75- 55		
Prickly-ash	D				
Redbud	D				
Sassafras	B	1	100- 80	90	
Sweetgum	B+	1-2	115- 95	102	
Sycamore, American	B	2	115- 95		
Tupelo, black	C	2	85- 65		
Walnut, black	B	2	95- 75		
Yellow-poplar	B+	1	125-105	112	

Table 28.—*The MORGANFIELD series is a member of the coarse-silty, mixed, nonacid, thermic family of Typic Udifluvents. These well-drained soils occur on bottoms within the Silty Uplands (MLRA-134). If surface layers are above pH 7.5, it should be considered unsuitable for planting oaks*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	6.0	6.0	6.3	6.3
Phosphorus, extractable	p/m	11	15	15	18
Potassium, extractable	p/m	52	34	30	30
Sodium, extractable	p m	17	20	47	36
Soluble salts	mmho/cm	11	8	8	10
Organic matter	% wt	1.58	.68	.58	.56
Cation exchange capacity	me/100 g	9	9	8	8
Exchangeable calcium	me/100 g	5.8	5.1	4.8	5.3
Exchangeable magnesium	me/100 g	2.4	2.4	2.3	3.1
Ca:Mg ratio		2.5	2.2	2.1	1.8
Base saturation	%	89	88	90	93
Sand	%/wt	12	14	14	16
Silt	%/wt	77	72	73	71
Clay	%/wt	11	14	13	13
Bulk density	g/cc	1.25	1.32	1.33	1.35
Moisture equivalent	%/vol	28	29	28	30
60-cm moisture	%/vol	42	41	40	41
15-bar moisture	%/vol	9	9	8	9
Usable water after drainage	%/vol	33	32	32	32
Total porosity	%/vol	53	50	50	49
Pore volume for potential drainage and aeration	%/vol	11	9	10	8

Table 28a.—*Species suitability and productivity on MORGANFIELD soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green	A	1	100- 80		95
Baldcypress	B	1-2	110- 90		
Basswood, American		(1-2)	100- 80		
Birch, river		(2)	85- 65		
Boxelder	C	1-2			
Catalpa	C				
Cherry, black	C	2	95- 75		
Chinaberry	C				
Cottonwood, eastern	A	1	130-110	115	112
Elderberry	D				
Elms, American and slippery	C+	1	95- 75	80	
Hackberry and sugarberry	B	1	100- 80		
Hickories		(2)	90- 70		
Honeylocust	C	2	85- 65		
Locust, black	C				
Maple, red and silver	C	2	90- 70		
Mulberry	C				
Oak, bur	B				
Oak, cherrybark	C	1-2	120-100	114	112
Oak, Nuttall	C	2	110- 90	105	
Oak, pin	C				
Oak, water	C	1-2	115- 95	108	107
Oak, willow	C	1-2	115- 95	105	
Pecan	B	1	110- 90		
Persimmon, common	C	2	85- 65		
Redbud	D				
Redcedar, eastern	C				
Sassafras	C	2	95- 75		
Sumac, smooth	D				
Sweetgum	B+	1	120-100	113	
Sycamore, American	A+	1	130-110	122	
Walnut, black	B	1-2	100- 80	80	
Yellow-poplar	A	1-2	125-105	118	

Table 29.—*The NEWELLTON series is a member of the clayey-over-loamy, montmorillonitic, nonacid, thermic family of Aeric Fluvaquents. These somewhat poorly drained soils are found mainly in Mississippi River alluvium within MLRA-131. If surface layers are above pH 7.5, it should be considered unsuitable for oaks*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	6.6	7.4	7.7	7.8
Phosphorus, extractable	p/m	15	9	7	7
Potassium, extractable	p/m	325	170	96	76
Sodium, extractable	p/m	58	54	50	40
Soluble salts	mmho/cm	58	70	60	62
Organic matter	%/wt	3.00	1.15	.95	.78
Cation exchange capacity	me/100 g	33	21	15	15
Exchangeable calcium	me/100 g	22.7	15.8	13.9	16.1
Exchangeable magnesium	me/100 g	7.6	5.7	3.6	2.3
Ca:Mg ratio		3.0	2.8	3.8	7.1
Base saturation	%	95	100	100	100
Sand	%/wt	11	16	22	24
Silt	%/wt	32	53	57	57
Clay	%/wt	57	31	21	19
Bulk density	g/cc	1.06	1.36	1.38	1.33
Moisture equivalent	%/vol	39	38	33	30
60-cm moisture	%/vol	56	44	44	45
15-bar moisture	%/vol	27	21	14	13
Usable water after drainage	%/vol	29	23	30	32
Total porosity	%/vol	60	49	48	50
Pore volume for potential drainage and aeration	%/vol	4	5	4	5

Table 29a.—*Species suitability and productivity on NEWELLTON soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green	A	2	90- 70		
Baldcypress		(1-2)	110- 90		
Basswood, American		(2)	95- 75		
Boxelder	C+				
Cherry, black		(2)	95- 75		
Cottonwood, eastern	A	1-2	125-105		
Dogwood, roughleaf	D				
Elm, American and slippery	C+	1	90- 70		
Hackberry and sugarberry	C+	1	100- 80		
Hawthorn	D				
Honeylocust	C	1	95- 75		
Maple, red and silver	C	2	90- 70		
Mulberry	C				
Oak, cherrybark	C	2-3	105- 85		
Oak, Nuttall	C	1-2	110- 90		
Oak, overcup		(2)	85- 65		
Oak, Shumard		(2)	110- 90		
Oak, water	C+	2-3	100- 80		
Oak, willow	C+	1-2	105- 85		
Osage-orange	C				
Pecan	B	1	110- 90		
Persimmon, common	C	2	85- 65		
Sassafras		(2)	95- 75		
Sumac, smooth	D				
Swamp-privet	D				
Sweetgum	A+	1-2	110- 90		
Sycamore, American	A	1	130-110	128	
Walnut, black	B	2	95- 75		

Table 30.—*The OCHLOCKONEE series is a member of the coarse-loamy, siliceous, acid, thermic family of Typic Udifluvents. These well-drained soils occur on stream floodplains on slopes of 0 to 2 percent within the Southern Coastal Plain (MLRA-133). If located on physiographically dry situations, these soils are not suitable for hardwoods*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	4.7	4.8	5.0	5.0
Phosphorus, extractable	p/m	14	13	11	16
Potassium, extractable	p/m	16	36	20	14
Sodium, extractable	p/m	28	46	39	22
Soluble salts	mmho/cm	0	0	0	0
Organic matter	% wt	.62	.41	.46	.46
Cation exchange capacity	me/100 g	5	6	7	8
Exchangeable calcium	me/100 g	3.1	4.3	5.3	5.5
Exchangeable magnesium	me/100 g	0.4	0.4	0.4	0.4
Ca:Mg ratio		7.4	9.9	12.0	13.1
Base saturation	%	74	82	84	77
Sand	%/wt	82	80	76	69
Silt	%/wt	8	8	12	19
Clay	%/wt	10	12	12	12
Bulk density	g/cc	1.08	1.33	1.23	1.28
Moisture equivalent	%/vol	10	13	15	15
60-cm moisture	%/vol	19	29	30	34
15-bar moisture	%/vol	4	7	7	7
Usable water after drainage	%/vol	15	22	23	27
Total porosity	%/vol	59	50	54	52
Pore volume for potential drainage and aeration	%/vol	40	21	24	18

Table 30a.—*Species suitability and productivity on OCHLOCKONEE soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green and white	C	3	80- 60		
Baldcypress	C	3	85- 65		
Basswood, American		(1-2)	100- 80		
Birch, river	C	1	90- 70	88	
Cherry, black	B	2	95- 75		
Cottonwood, eastern	C	3	100- 80		
Dogwood, flowering	C				
Elms	C+	2	75- 55		
Hackberry and sugarberry	C	2	90- 70		
Hickories (except water)	B	1	100- 80		
Holly, American	C				
Honeylocust		(3)	80- 60		
Hophornbeam, eastern	D				
Hornbeam, American	D				
Locust, black	C				
Maple, red and silver	C	2	90- 70		
Oak, cherrybark	B	1	120-100		112
Oak, Nuttall		(2)	110- 90		
Oak, overcup		(3)	80- 60		
Oak, Shumard	A	1	115- 95		
Oak, southern red	C				
Oak, swamp chestnut		(2)	95- 75		
Oak, water	B+	1-2	110- 90	110	108
Oak, white	B	1	105- 85		
Oak, willow	B	2	105- 85	90	105
Pecan		(2)	100- 80		
Persimmon, common	C	3	75- 55		
Redbud	D				
Sassafras	B	1-2	100- 80		
Sumac, smooth	D				
Sweetgum	A+	1-2	115- 95	112	
Sycamore, American	A	1-2	120-100	115	
Tupelo, black	B	2	85- 65		
Walnut, black	C	2	95- 75		
Yellow-poplar	A	1-2	115- 95		

Table 31.—*The PERRY series is a member of the very fine, montmorillonitic, nonacid, thermic family of Vertic Haplaquepts. The soils have gray clay A and B horizons over reddish-brown IIB horizons at depths of 14 to 36 inches. These poorly drained soils occur on mixed alluvium from the Mississippi, Arkansas, and Red Rivers (MLRA-131). If waterlogged for one or more growing seasons, these soils are not suitable for hardwoods. There should be no free water in the surface foot of soil during parts of July, August, and September to obtain productivity within the estimated range.*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	4.6	4.8	5.2	6.8
Phosphorus, extractable	p/m	16	18	15	13
Potassium, extractable	p/m	136	158	175	185
Sodium, extractable	p m	76	60	230	228
Soluble salts	mmho/cm	44	32	95	256
Organic matter	%/wt	2.38	.73	.76	.53
Cation exchange capacity	me/100 g	29	38	44	41
Exchangeable calcium	me/100 g	9.8	13.5	17.0	37.0
Exchangeable magnesium	me/100 g	6.0	11.0	16.4	16.4
Ca:Mg ratio		1.7	1.2	1.1	2.6
Base saturation	%	59	70	95	100
Sand	% wt	11	6	4	4
Silt	%/wt	39	32	26	32
Clay	%/wt	50	62	70	64
Bulk density	g/cc	1.26	1.21	1.21	1.21
Moisture equivalent	%/vol	44	52	54	54
60-cm moisture	%/vol	44	53	54	54
15-bar moisture	%/vol	26	30	32	30
Usable water after drainage	%/vol	18	23	22	24
Total porosity	%/vol	52	54	54	54
Pore volume for potential drainage and aeration	%/vol	8	1	0	0

Table 31a.—*Species suitability and productivity on PERRY soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green	A+	2-3	80- 60	69	
Baldcypress	C	2	95- 75		
Cottonwood, eastern	A	3	95- 75		
Cottonwood, swamp	C				
Dogwood, roughleaf	D				
Elms	C	2	75- 55		
Hackberry and sugarberry	C	3	75- 55	65	
Hawthorn	D				
Hickories	C+	3	75- 55	68	
Honeylocust	C+	2-3	75- 55	67	
Oak, cherrybark	B+	3	90- 70	74	
Oak, laurel		(2)	100- 80		
Oak, Nuttall	A+	2-3	95- 75	81	
Oak, overcup	C+	2	85- 65		
Oak, swamp chestnut	C	3	85- 65	70	
Oak, swamp post	C	2	85- 65	72	
Oak, water	B	2-3	85- 65	69	
Oak, white		(3)	80- 60		
Oak, willow	B+	2-3	90- 70	87	
Pecan	C	3	90- 70		
Persimmon, common	C	3	75- 55		
Planertree	D				
Sumac, smooth	D				
Swamp-privet	D				
Sweetgum	A	3	90- 70		
Sycamore, American	B	3	95- 75		
Tupelo, black		(2)	85- 65		
Tupelo, water		(2)	90- 70		
Willow, black	C	2	90- 70		
Yellow-poplar		(4)	<65		

Table 32.—*The RILLA series is a member of the fine-silty, mixed, thermic family of Typic Hapludalfs. These reddish-brown, well-drained, acid soils occur mainly on gently sloping topography in Arkansas River alluvium within MLRA-131*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	4.6	4.6	4.6	4.6
Phosphorus, extractable	p m	18	4	3	9
Potassium, extractable	p/m	50	56	90	45
Sodium, extractable	p/m	32	62	184	196
Soluble salts	mmho/cm	18	12	14	31
Organic matter	% wt	1.98	.62	.38	.28
Cation exchange capacity	me/100 g	10	13	21	12
Exchangeable calcium	me/100 g	4.2	4.4	6.0	3.4
Exchangeable magnesium	me/100 g	2.5	3.3	5.8	3.4
Ca:Mg ratio		1.7	1.3	1.0	1.0
Base saturation	%	67	65	63	70
Sand	%/wt	31	28	17	34
Silt	%/wt	51	49	48	47
Clay	%/wt	18	23	35	19
Bulk density	g/cc	1.49	1.28	1.32	1.36
Moisture equivalent	%/vol	31	28	38	28
60-cm moisture	%/vol	37	37	45	37
15-bar moisture	%/vol	12	13	22	12
Usable water after drainage	%/vol	25	24	23	25
Total porosity	%/vol	44	52	50	49
Pore volume for potential drainage and aeration	%/vol	7	15	15	12

Table 32a.—*Species suitability and productivity on RILLA soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green	C	2-3	85- 65		75
Basswood, American		(1-2)	100- 80		
Birch, river		(1-2)	90- 70		
Cherry, black		(1-2)	100- 80		
Cottonwood, eastern	A	2-3	105- 85		86
Elms	C+	2	85- 65	70	
Hackberry and sugarberry	C	2	90- 70		
Hickories (except water)	C	1	95- 75		
Honeylocust		(3)	80- 60		
Maple, red	C	2	90- 70		
Mulberry	C				
Oak, cherrybark	B+	1-2	110- 90	93	92
Oak, Nuttall	A	2	105- 85		86
Oak, overcup		(3)	80- 60		
Oak, Shumard		(1)	115- 95		
Oak, swamp chestnut	B	2	95- 75	78	
Oak, swamp post	C				
Oak, water	B+	2	100- 80	86	87
Oak, white		(1)	110- 90		
Oak, willow	B+	2	105- 85		91
Pecan	C	2	100- 80		
Persimmon, common	C	3	75- 55		
Sassafras		(1-2)	100- 80		
Swamp-privet	D				
Sweetgum	A+	2	105- 85	85	
Sycamore, American	A	1-2	115- 95		
Tupelo, black		(1-2)	90- 70		
Walnut, black		(1-2)	100- 80		
Yellow-poplar		(2)	100- 80		

Table 33.—*The ROBINSONVILLE series is a member of the coarse-loamy, mixed, nonacid, thermic family of Typic Udifluvents. These well-drained soils are on slopes of 0 to 3 percent in loamy alluvium of the Mississippi River (MLRA-131). If surface layers are above pH 7.5, the soils should be considered unsuitable for planting oaks. If located on physiographically dry situations, these soils are not suitable for hardwoods*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	6.7	6.5	6.4	6.4
Phosphorus, extractable	p/m	24	14	18	19
Potassium, extractable	p/m	232	177	76	64
Sodium, extractable	p/m	18	24	11	6
Soluble salts	mmho/cm	1	0	0	0
Organic matter	%/wt	2.67	1.20	.55	.46
Cation exchange capacity	me/100 g	26	18	10	9
Exchangeable calcium	me/100 g	17.2	11.6	6.4	6.0
Exchangeable magnesium	me/100 g	7.4	4.9	2.5	2.4
Ca:Mg ratio		2.3	2.4	2.6	2.5
Base saturation	%	97	95	98	95
Sand	%/wt	9	38	63	53
Silt	%/wt	51	35	25	37
Clay	%/wt	40	27	12	10
Bulk density	g/cc	1.26	1.38	1.46	1.36
Moisture equivalent	%/vol	40	33	18	16
60-cm moisture	%/vol	42	34	37	38
15-bar moisture	%/vol	19	13	6	5
Usable water after drainage	%/vol	23	21	31	33
Total porosity	%/vol	52	48	45	49
Pore volume for potential drainage and aeration	%/vol	10	14	8	11

Table 33a.—*Species suitability and productivity on ROBINSONVILLE soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green	C	2	90- 70		94
Birch, river		(2)	85- 65		
Boxelder	C+	1	75- 55	65	
Cherry, black		(2)	95- 75		
Chinaberry	C				
Cottonwood, eastern	A+	1-2	120-100	110	108
Elms, American and slippery	C+	1-2	90- 70	75	
Hackberry and sugarberry	B+	1	95- 75		
Honeylocust		(3)	80- 60		
Locust, black	C				
Maple, red and silver	C	2	90- 70		
Oak, cherrybark	C	2-3	110- 90		109
Oak, Nuttall	C	2-3	105- 85		
Oak, overcup		(3)	80- 60		
Oak, Shumard		(2)	110- 90		
Oak, water	C	2-3	105- 85		104
Oak, willow	C	2-3	105- 85		103
Osage-orange	C				
Pecan	B	1	115- 95		
Persimmon, common	C	3	75- 55		
Sassafras	C	2	95- 75		
Sweetgum	A	1-2	115- 95	109	
Sycamore, American	A+	1	125-105	115	
Walnut, black	B	2	95- 75		
Yellow-poplar		(2)	100- 80		

Table 34.—*The ROSEBLOOM series is a member of the fine-silty, mixed, acid, thermic family of Typic Fluvaquents. These poorly drained soils occur on flat topography along river bottoms throughout the Silty Uplands (MLRA-134). If waterlogged throughout one or more growing seasons, they are unsuitable for hardwoods. There should be no free water in the surface foot of soil during parts of July, August, and September to obtain productivity within the estimated range*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	4.9	5.1	5.3	5.6
Phosphorus, extractable	p/m	10	5	4	3
Potassium, extractable	p/m	42	44	27	44
Sodium, extractable	p/m	8	8	66	132
Soluble salts	mmho/cm	8	6	10	20
Organic matter	% wt	2.44	1.18	.68	.51
Cation exchange capacity	me/100 g	8	7	10	13
Exchangeable calcium	me/100 g	1.7	2.7	3.1	4.7
Exchangeable magnesium	me/100 g	1.0	1.4	2.5	4.0
Ca:Mg ratio		1.6	1.8	1.1	1.1
Base saturation	%	37	61	59	72
Sand	%/wt	17	20	19	18
Silt	%/wt	59	58	52	48
Clay	%/wt	24	22	28	33
Bulk density	g/cc	1.32	1.43	1.41	1.44
Moisture equivalent	%/vol	33	31	32	36
60-cm moisture	%/vol	39	35	35	38
15-bar moisture	%/vol	10	9	12	16
Usable water after drainage	%/vol	29	26	23	22
Total porosity	%/vol	50	46	47	46
Pore volume for potential drainage and aeration	%/vol	11	11	12	8

Table 34a.—*Species suitability and productivity on ROSEBLOOM soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green and white	A+	1	105- 85	93	82
Baldcypress	C	2	95- 75		
Basswood, American		(2)	95- 75		
Buttonbush, common	D				
Cottonwood, Eastern	A	2	110- 90		91
Cottonwood, swamp	C				
Elms	C+	3	80- 60	65	
Hackberry and sugarberry	C	2	90- 70		
Hawthorn	D				
Hickories	C	1-2	90- 70	81	
Honeylocust	C	2	85- 65		
Hophornbeam, eastern	D				
Hornbeam, American	D				
Maple, red	C	3	85- 65		
Mulberry	C				
Oak, cherrybark	B+	2	105- 85	87	97
Oak, laurel	B	2	105- 85	98	
Oak, Nuttall	B	1-2	105- 85		91
Oak, overcup	C+	1	100- 80		
Oak, Shumard	C	2-3	100- 80	85	
Oak, swamp chestnut	B	2	95- 75	80	
Oak, water	B+	2	105- 85	99	92
Oak, white	C	2	95- 75	84	
Oak, willow	B	2	100- 80	85	94
Pecan		(3)	90- 70		
Persimmon, common	C	2	85- 65		
Redcedar, eastern	C				
Swamp-privet	D				
Sweetgum	A+	2	105- 85	92	
Sycamore, American	A	2-3	100- 80	90	
Tupelo, black	C	2	85- 65		
Tupelo, swamp	C				
Tupelo, water	B	1-2	100- 80		
Willow, black	C	2	90- 70		
Yellow-poplar	C	3	85- 65		

Table 35.—*The SHARKEY series is a member of the very fine, montmorillonitic, nonacid, thermic family of Vertic Haplaquepts. The series consists of poorly drained, very dark grayish-brown clay surface and dark gray, clay subsoil mottled with yellowish-brown. It occurs in depressions and slackwater areas from Mississippi River sediments (MLRA-131). Slopes range from 0 to 3 percent. If surface layers are above pH 7.5, it should be considered unsuitable for planting oaks. If waterlogged throughout one or more growing seasons, it is unsuitable for hardwoods. There should be no free water in the surface foot of soil during parts of July, August, and September to obtain productivity within the estimated range*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	5.9	6.0	6.4	6.7
Phosphorus, extractable	p/m	25	17	16	15
Potassium, extractable	p/m	280	233	220	213
Sodium, extractable	p/m	114	146	190	214
Soluble salts	mmho/cm	18	18	37	71
Organic matter	%/wt	2.88	1.41	1.10	1.02
Cation exchange capacity	me/100 g	40.6	38.6	40.8	43.2
Exchangeable calcium	me/100 g	26.4	23.7	26.9	30.8
Exchangeable magnesium	me/100 g	8.4	9.0	10.0	11.3
Ca:Mg ratio		3.06	2.68	2.72	2.88
Base saturation	%	87.1	87.5	93.8	99.2
Sand	%/wt	11	8	9	9
Silt	%/wt	24	23	23	24
Clay	%/wt	65	68	68	67
Bulk density	g/cc	1.07	1.16	1.22	1.25
Moisture equivalent	%/vol	50	56	58	59
60-cm moisture	%/vol	54	54	55	54
15-bar moisture	%/vol	30	32	33	33
Usable water after drainage	%/vol	24	22	22	21
Total porosity	%/vol	60	56	54	54
Pore volume for potential drainage and aeration	%/vol	6	2	0	0

Table 35a.—*Species suitability and productivity on SHARKEY soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green	A+	2	95- 75	80	78
Baldcypress	C	2	95- 75		
Boxelder	D				
Catalpa	C				
Chinaberry	C				
Coffeetree, Kentucky	C				
Cottonwood, eastern	A	2-3	105- 85	92	88
Cottonwood, swamp	C				
Dogwood, roughleaf	D				
Elms, American, slippery, and cedar	C+	2-3	85- 65	74	
Hackberry and sugarberry	C+	2-3	85- 65	73	
Hawthorn	D				
Hickories (except water)	C	3	80- 60		
Hickory, water	C+	2	85- 65	77	
Honeylocust	C	1-2	90- 70	79	
Locust, black	C				
Maple, red	C+	3	85- 65	72	
Mulberry	C				
Oak, bur	C				
Oak, cherrybark	C	3	95- 75	84	93
Oak, laurel	C	3	85- 65	70	
Oak, Nuttall	A+	2	100- 80	91	92
Oak, overcup	C+	2	85- 65	74	
Oak, swamp post	C				
Oak, swamp chestnut	C	2-3	90- 70	70	
Oak, water	B+	2	100- 80	85	92
Oak, willow	B+	2	105- 85	92	93
Osage-orange	D				
Pecan	C+	2-3	90- 70	80	
Persimmon, common	C	2	85- 65	73	
Planertree	D				
Sassafras	C	3	90- 70		
Swamp-privet	D				
Sweetgum	A+	2	100- 80	88	
Sycamore, American	A	2-3	100- 80	87	
Tupelo, black	C	3	80- 60		
Tupelo, water	C	3	80- 60		
Willow, black	C	2	90- 70	80	
Yellow-poplar		(3)	85- 65		

Table 36.—*The TENSAS series is a member of the fine, montmorillonitic, thermic family of Vertic Ochraqualfs. These somewhat poorly drained acid soils occur mainly on gently sloping land developed from Mississippi River sediments (MLRA-131)*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	4.8	5.1	5.0	5.2
Phosphorus, extractable	p m	20	20	26	36
Potassium, extractable	p/m	177	152	118	76
Sodium, extractable	p/m	34	38	44	62
Soluble salts	mmho/cm	12	7	7	9
Organic matter	% wt	2.33	1.00	.62	.44
Cation exchange capacity	me/100 g	28	32	26	19
Exchangeable calcium	me/100 g	10.8	11.7	10.2	7.9
Exchangeable magnesium	me/100 g	4.9	5.4	4.9	4.1
Ca:Mg ratio		2.1	2.2	2.1	2.0
Base saturation	%	58	57	65	70
Sand	% wt	17	17	30	42
Silt	%/wt	32	34	36	35
Clay	%/wt	51	49	34	23
Bulk density	g/cc	1.12	1.25	1.39	1.40
Moisture equivalent	%/vol	40	44	42	32
60-cm moisture	%/vol	48	46	44	42
15-bar moisture	%/vol	23	26	21	16
Usable water after drainage	%/vol	25	20	23	26
Total porosity	%/vol	58	53	48	47
Pore volume for potential drainage and aeration	%/vol	10	7	4	5

Table 36a.—*Species suitability and productivity on TENSAS soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green	A+	2	95- 75	78	89
Baldcypress	C	2	95- 75		
Basswood, American		(2)	95- 75		
Boxelder	D				
Chinaberry	C				
Cottonwood, eastern	A	2	110- 90	103	100
Cottonwood, swamp	C				
Dogwood, roughleaf	D				
Elms, American and slippery	C+	2	75- 55		
Elms, cedar, rock, winged	C	2			
Hackberry and sugarberry	C+	2	90- 70		
Hawthorn	D				
Hickories (except water)	C	2	90- 70		
Hickory, water	C	2	85- 65	72	
Holly, American	D				
Honeylocust	C	2	85- 65		
Hophornbeam, eastern	D				
Hornbeam, American	D				
Maple, red	C	3	85- 65		
Mulberry	C				
Oak, cherrybark	B+	1-2	115- 95	108	104
Oak, laurel		(1-2)	105- 85		
Oak, Nuttall	A+	2	110- 90	98	100
Oak, overcup	C	1	95- 75	80	
Oak, Shumard	A	2	105- 85		
Oak, swamp chestnut	B	2	100- 80		
Oak, water	B+	2	105- 85	97	99
Oak, white		(2)	100- 80		
Oak, willow	B+	2	105- 85	100	99
Pecan	B	2	95- 75	80	
Persimmon, common	C	2	85- 65		
Redbud	D				
Sassafras	C	3	90- 70		
Swamp-privet	D				
Sweetgum	A+	2	110- 90	102	
Sycamore, American	A	2	105- 85	105	
Tupelo, black	C	2	85- 65	70	
Tupelo, water		(2)	90- 70		
Willow, black	C	1-2	100- 80	95	
Yellow-poplar		(3)	85- 65		

Table 37.—*The TUNICA series is a member of the clayey-over-loamy, montmorillonitic, nonacid, thermic family of Vertic Haplaquepts. Depth of loamy materials is about 30 inches. These poorly drained, clay soils occur on slopes of 0 to 3 percent along the Mississippi River bottoms (MLRA-131). If surface layers are above pH 7.5, the soil should be considered unsuitable for oaks*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	5.6	5.8	6.0	6.1
Phosphorus, extractable	p/m	24	24	22	23
Potassium, extractable	p/m	270	180	138	92
Sodium, extractable	p/m	65	66	60	59
Soluble salts	mmho/cm	20	14	15	14
Organic matter	%/wt	2.93	1.69	.78	.62
Cation exchange capacity	me/100 g	39.7	35.2	30.2	20.0
Exchangeable calcium	me/100 g	22.2	19.6	16.8	12.0
Exchangeable magnesium	me/100 g	7.9	8.0	7.6	4.8
Ca:Mg ratio		2.81	2.45	2.21	2.50
Base saturation	%	78	80	83	88
Sand	%/wt	15	16	17	23
Silt	%/wt	27	30	41	50
Clay	%/wt	58	53	42	27
Bulk density	g/cc	1.10	1.26	1.34	1.33
Moisture equivalent	%/vol	48	49	46	36
60-cm moisture	%/vol	51	50	44	41
15-bar moisture	%/vol	30	29	26	19
Usable water after drainage	%/vol	21	21	18	22
Total porosity	%/vol	58	52	50	50
Pore volume for potential drainage and aeration	%/vol	7	2	6	9

Table 37a.—*Species suitability and productivity on TUNICA soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green	A	2	90- 70		77
Boxelder	C				
Catalpa	C				
Chinaberry	C				
Cottonwood, eastern	A	2	110- 90		87
Dogwood, roughleaf	D				
Elms, American and slippery	C+	2	75- 55		
Elms, cedar and winged	C	2			
Hackberry and sugarberry	C	2	90- 70		
Hawthorn	D				
Hickories		(3)	80- 60		
Honeylocust	C	2	85- 65	70	
Locust, black	C				
Maple, red	C	2	90- 70	80	
Mulberry	C				
Oak, bur	C				
Oak, cherrybark	B	2	105- 85	96	93
Oak, Nuttall	A+	1-2	110- 90	98	86
Oak, overcup	C	2	85- 65		
Oak, Shumard	C	2	110- 90		
Oak, swamp chestnut	C	2	95- 75		
Oak, water	B+	2	100- 80	88	89
Oak, willow	B+	2	100- 80	90	88
Osage-orange	C				
Pecan	C	2	100- 80		
Persimmon, common	C	2	85- 65		
Redbud	D				
Sassafras	C	3	90- 70		
Sumac, smooth	D				
Swamp-privet	D				
Sweetgum	A+	2	105- 85	86	
Sycamore, American	A	2	110- 90		
Tupelo, black	C	3	80- 60		
Tupelo, water	C	3	80- 60		
Willow, black	C	2	90- 70		
Yellow-poplar		(3)	85- 65		

Table 38.—*The UNA series is a member of the fine, mixed, acid, thermic family of Typic Haplaquepts. These poorly drained soils occur on level land along streams and rivers within the Blackland Prairies (MLRA-135) and Coastal Plain (MLRA-133). If waterlogged throughout one or more growing seasons, they are unsuitable for hardwoods. There should be no free water in the surface foot of soil during parts of July, August, and September to obtain productivity within the estimated range.*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	4.0	4.1	3.6	4.4
Phosphorus, extractable	p/m	4	2	Tr	Tr
Potassium, extractable	p/m	34	21	28	34
Sodium, extractable	p/m	20	24	69	106
Soluable salts	mmho/cm	11	2	10	20
Organic matter	% wt	2.08	.74	.55	.42
Cation exchange capacity	me/100 g	15	12	14	18
Exchangeable calcium	me/100 g	2.2	0.7	2.0	3.2
Exchangeable magnesium	me/100 g	1.0	0.7	1.8	3.1
Ca:Mg ratio		2.2	0.9	1.1	1.0
Base saturation	%	23	13	30	40
Sand	%/wt	26	29	26	23
Silt	%/wt	39	34	35	32
Clay	%/wt	35	37	39	45
Bulk density	g/cc	.92	1.44	1.06	1.17
Moisture equivalent	%/vol	24	33	26	32
60-cm moisture	%/vol	54	46	50	50
15-bar moisture	%/vol	13	16	14	18
Usable water after drainage	%/vol	41	30	36	32
Total porosity	%/vol	65	46	60	54
Pore volume for potential drainage and aeration	%/vol	11	0	10	4

Table 38a.—*Species suitability and productivity on UNA soils.*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green and white	A+	2-3	85- 65	68	76
Baldcypress		(2)	95- 75		
Buttonbush	D				
Cottonwood, eastern	B	3	95- 75		85
Elms	C	2	75- 55		
Hackberry and sugarberry	C	3	75- 55		
Hickories	C+	2	90- 70		
Holly, American	D				
Honeylocust	C	2	85- 65		
Maple, red	C	3	85- 65		
Oak, cherrybark	B	2	100- 80	86	91
Oak, laurel	B	2	100- 80		
Oak, Nuttall	A	2	105- 85		86
Oak, overcup	B	2	85- 65		
Oak, Shumard		(2)	110- 90		
Oak, swamp chestnut	B	2-3	90- 70		
Oak, water	B+	2	100- 80	84	88
Oak, white		(2)	100- 80		
Oak, willow	B+	2	100- 80	82	90
Pecan		(3)	90- 70		
Planertree	D				
Swamp-privet	D+				
Sweetbay	C				
Sweetgum	A+	2	100- 80	85	
Sycamore, American	C	3	90- 70		
Tupelo, black		(2)	85- 65		
Tupelo, swamp	C	2	85- 65		
Tupelo, water	A	2	90- 70		
Willow, black		(2)	90- 70		
Yellow-poplar		(3)	85- 65		

Table 39.—*The URBO series is a member of the fine, mixed, acid, thermic family of Aeric Haplaquepts. These somewhat poorly drained soils occur along floodplains within the Blacklands (MLRA-135) and Coastal Plain (MLRA-133)*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	5.0	4.8	4.5	4.4
Phosphorus, extractable	p m	17	11	10	6
Potassium, extractable	p/m	100	88	92	98
Sodium, extractable	p/m	63	79	98	124
Soluble salts	mmho/cm	26	29	59	48
Organic matter	% wt	2.21	1.08	.48	.39
Cation exchange capacity	me/100 g	17	19	18	18
Exchangeable calcium	me/100 g	14.5	10.7	6.8	5.9
Exchangeable magnesium	me/100 g	1.9	1.8	1.7	1.6
Ca:Mg ratio		7.2	5.6	3.9	4.1
Base saturation	%	69	65	54	49
Sand	%/wt	23	25	24	26
Silt	%/wt	37	35	35	34
Clay	%/wt	40	40	41	40
Bulk density	g/cc	1.18	1.27	1.20	1.23
Moisture equivalent	%/vol	35	37	34	36
60-cm moisture	%/vol	42	41	38	40
15-bar moisture	%/vol	18	19	18	18
Usable water after drainage	%/vol	28	22	20	22
Total porosity	%/vol	56	52	55	54
Pore volume for potential drainage and aeration	%/vol	14	11	17	14

Table 39a.—*Species suitability and productivity on URBO soils*

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green and white	A+	1-2	100- 80	91	80
Basswood, American		(2)	95- 75		
Cherry, black		(2)	95- 75		
Cottonwood, eastern	A	2	110- 90		89
Elms	C	2	75- 55		
Hackberry and surgarberry	C	2	90- 70		
Hawthorn	D				
Hickories (except water)	B+	1	95- 75	84	
Holly, American	C				
Honeylocust	C	2	85- 65		
Hophornbeam, eastern	D+				
Hornbeam, American	D+				
Locust, black	C				
Maple, red	B	2	90- 70		
Oak, cherrybark	B	1-2	115- 95	100	95
Oak, laurel	B	2	100- 80		
Oak, Nuttall	A	1-2	110- 90	108	90
Oak, overcup	B	1	95- 75	84	
Oak, post	C				
Oak, Shumard	A	2	105- 85	92	
Oak, swamp chestnut	B	2	100- 80		
Oak, water	B+	1-2	110- 90	96	91
Oak, white		(1)	110- 90		
Oak, willow	B+	1-2	110- 90	102	92
Pecan		(2)	100- 80		
Persimmon, common	B	2	85- 65		
Plum, flatwoods	D				
Sassafras		(2)	95- 75		
Sweetgum	A+	1-2	110- 90	90	
Sycamore, American	A	2	110- 90	105	
Tupelo, black	C	2	85- 65		
Tupelo, water		(2)	90- 70		
Walnut, black		(2)	95- 75		
Yellow-poplar		(2)	100- 80		

Table 40.—*The VICKSBURG series is a member of the coarse-silty, mixed, acid, thermic family of Typic Udifluvents. These well-drained, silty soils occur in floodplains and drainageways within the Silty Uplands (MLRA-134)*

Property	Unit	Soil depth in inches			
		0-12	12-24	24-36	36-48
Soil reaction	pH	5.3	5.3	5.4	5.4
Phosphorus, extractable	p m	27	26	25	25
Potassium, extractable	p/m	63	56	50	48
Sodium, extractable	p/m	28	28	26	26
Soluble salts	mmho/cm	13	9	7	8
Organic matter	%/wt	1.55	.78	.70	.70
Cation exchange capacity	me/100 g	11	10	10	10
Exchangeable calcium	me/100 g	5.0	4.2	4.5	5.0
Exchangeable magnesium	me/100 g	2.2	2.2	1.8	1.9
Ca:Mg ratio		2.3	2.0	2.3	2.7
Base saturation	%	69	68	70	74
Sand	%/wt	13	15	13	14
Silt	%/wt	73	70	71	70
Clay	%/wt	14	15	15	16
Bulk density	g/cc	1.37	1.34	1.35	1.35
Moisture equivalent	%/vol	32	29	30	30
60-cm moisture	%/vol	43	42	41	42
15-bar moisture	%/vol	11	10	10	10
Usable water after drainage	%/vol	32	32	31	32
Total porosity	%/vol	48	50	49	49
Pore volume for potential drainage and aeration	%/vol	5	8	8	7

Species	Management and occurrence	Suitability	Site index		
			Estimated range	Measured average	Converted from sweetgum
Ash, green and white	A	1	100- 80		89
Basswood, American	C	2	95- 75		
Beech, American	C				
Birch, river	C	2	85- 65		
Cherry, black	C	2	95- 75		
Cottonwood, eastern	A	1-2	120-100	114	101
Cucumbertree	C				
Dogwood, flowering	C				
Elms	C+	1-2	90- 70	75	
Hackberry and surgarberry	C	1	100- 80		
Hickories (except water)	C+	1	95- 75		
Holly, American	C				
Honeylocust	C	2	85- 65		
Hophornbeam, eastern	D				
Hornbeam, American	D				
Locust, black	C				
Magnolia, southern	C				
Maple, red	C	2	90- 70		
Mulberry	C				
Oak, cherrybark	B+	1	120-100	112	104
Oak, laurel		(2)	100- 80		
Oak, Nuttall	A	1-2	115- 95		102
Oak, overcup		(2)	85- 65		
Oak, Shumard	A	1	115- 95	101	
Oak, southern red	C				
Oak, swamp chestnut	B	1	100- 80		
Oak, water	B+	1	110- 90	107	100
Oak, white	B	1	105- 85		
Oak, willow	B	1	110- 90		98
Pecan	B	1	110- 90		
Persimmon, common	C	2	85- 65		
Prickly-ash	D				
Redbud	D				
Redcedar, eastern	C				
Sassafras	C	2	95- 75	80	
Sweetgum	A+	1	115- 95	102	
Sycamore, American	A	1	125-105	114	
Tupelo, black	C	2	85- 65		
Tupelo, water		(2)	90- 70		
Walnut, black	B	2	95- 75		
Yellow-poplar	A+	1	120-100	106	

Broadfoot, Walter M.

1976. Hardwood suitability for and properties of important Midsouth soils. South. For. Exp. Stn., New Orleans, La. 84p. (USDA For. Serv. Res. Pap. SO-127).

Tables present descriptions and properties of 40 important Midsouth soils and show management suggestions, occurrence, and suitability ratings of species.

Additional key words: Site index, growth potential.

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Effective Allocation of Cost-Sharing Funds For Forestry: An Example

Paul A. Murphy

Southern Forest Experiment Station
Forest Service
U. S. Department of Agriculture

1976

Murphy, Paul A.
1976. Effective allocation of cost-sharing funds for forestry: an example. South. For. Exp. Stn., New Orleans, La. 14 p. (USDA For. Serv. Res. Pap. SO-128)

A procedure was developed to identify and rank geographic areas which offer the best potential for investment in type conversion in western Louisiana. This procedure can help decisionmakers in the regional allocation of cost-sharing funds. It is also applicable to other forest practices besides type conversion.

Additional keywords: Parametric linear programming, economic analysis, regional analysis, forest investment.

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Additional keywords: Parametric linear programming, economic analysis, regional analysis, forest investment.

EFFECTIVE ALLOCATION OF COST-SHARING FUNDS FOR FORESTRY: AN EXAMPLE

Paul A. Murphy

SUMMARY

The Forestry Incentives Program provides cost-sharing to private landowners for certain forestry practices, but how can limited public funds be directed to those areas where they will produce the greatest return? One way is through parametric linear programming. It enables administrators to rank areas on the basis of economic potential, taking into account not only the area's potential productivity but also factors such as treatment costs and manpower limitations.

To demonstrate the procedure, we considered the problem of allocating funds for converting low-grade hardwood stands to more productive pine in western Louisiana.

First, conversion classes were established according to type of regeneration needed, stand size, and site index. Next the study area was screened to determine the acreage in each class, and management costs and projected yields and prices were determined. Conversion classes were then ranked by parametric linear programming with net present value as the investment criterion.

However, these rankings were for western Louisiana as a whole. Parishes (counties) with the greatest economic potential for type conversion still had to be identified. To do this, the ratio of net present value to conversion cost was calculated for each conversion class. This ratio was then multiplied by each parish's acreage in that class. The weighted ratios for all conversion classes within a parish were then added, and the parishes were ranked.

As a demonstration of the versatility of the procedure, an arbitrary limitation on nursery capacity was then imposed, and the parishes were ranked again.

The Forestry Incentives Act of 1973 provides cost-sharing to private landowners for certain forestry practices. The law stipulates that funds be directed to those areas where they can produce the greatest return, but few criteria now exist to guide decisionmakers in allocating monies. Productivity alone may not be sufficient because factors like treatment cost can also affect economic value. State officials need some means of ranking counties so that they can select those eligible for program participation.

This paper demonstrates a procedure that can guide allocation of cost-sharing funds, such as in the Forestry Incentives Program, at the State or regional level. The allocation of funds for converting low-grade hardwood stands to more productive pine in western Louisiana is used as an example.

THE PROCEDURE

In the West Gulf Coastal Plain, about 11 million acres of hardwood forests are growing on sites better suited to pine. Converting these areas to pine is one of the best ways to increase the region's timber supply. Because of its potential, type conversion was chosen as the forest practice to illustrate the procedure for allocating cost-sharing funds. Methodology developed for the Central Gulf (Murphy 1976a) was modified for the West Gulf with western Louisiana (fig. 1) as the study area. Basic data for this study come from the latest forest survey of Louisiana (Murphy 1975).

Conversion Opportunities Were Identified

Hardwood stands, the oak-pine and oak-hickory forest types, that occur on land better suited for southern pine were considered candidates for type conversion. These stands were classified according to type of regeneration needed, stand size, and site productivity.

Regeneration by natural means or by planting were the two modes considered for producing the new pine stand. Although the technology of direct seeding is well developed (Derr and Mann 1971), it was not considered because little information is available about the yield of direct-seeded stands. If an adequate pine seed source was present, natural regeneration to the most plentiful pine species in the existing stand was assumed. If the seed source was inadequate, regeneration would

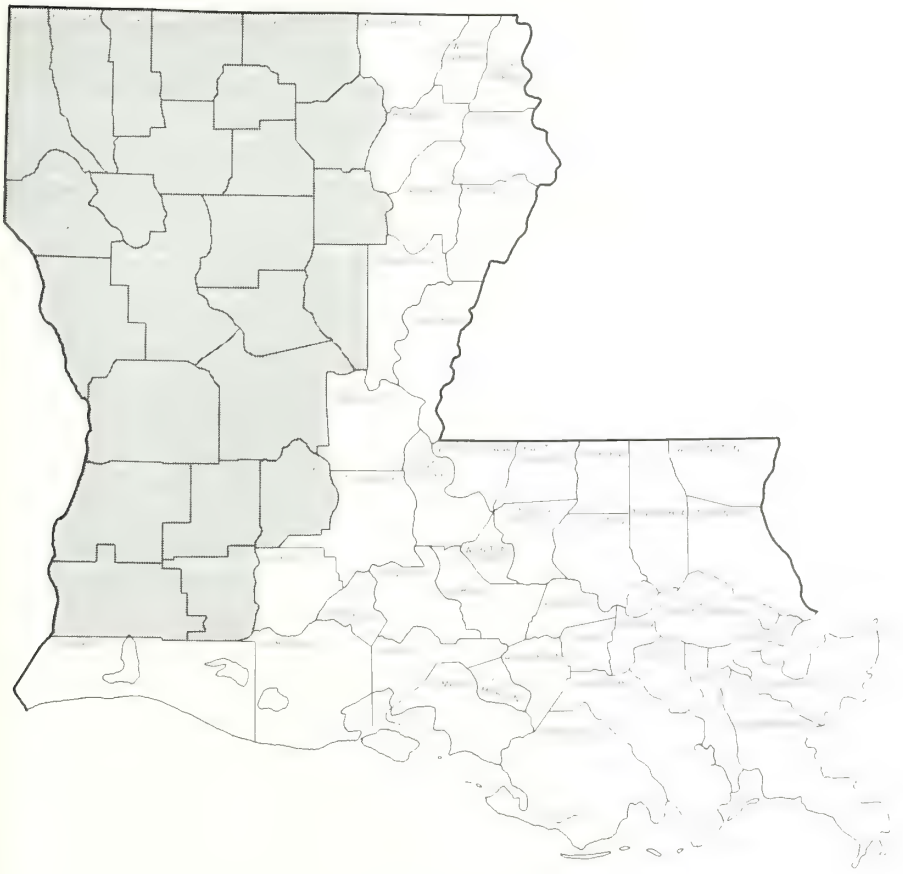

Figure 1.--*Study area in Louisiana.*

be by planting either loblolly (*Pinus taeda* L.) or longleaf (*P. palustris* Mill.). The pine species having the most stocking in the existing stand was the one chosen for planting. If neither loblolly nor longleaf was present, the species to be planted was determined by geographic location. Longleaf would be planted in Beauregard, Calcasieu, and Vernon Parishes, which lie within the boundary of the longleaf forest type (USDA Forest Service 1969); and loblolly pine, elsewhere. Slash pine (*P. elliottii* var. *elliottii* Engelm.) was not considered because it is not indigenous to the area.

Because stand size is a determinant of site preparation cost, sawtimber stands were separated from the smaller ones. The number of hardwood trees 10 inches or larger in diameter was also calculated.

Productivity for pine was derived from site index measurements on trees on the plot (table 1). If there were no index

Table 1.--*Productivity level by site index for western Louisiana*

Productivity level	Site index (50-year basis)		
	Loblolly	Longleaf	Shortleaf
	Feet		
1	95+	...	86+
2	80-94	89+	72-85
3	60-79	68-88	54-71
4	51-59	49-67	38-53

trees, plots were assigned a productivity level based upon the average site index for the parish.

There were five species-regeneration combinations, two stand sizes, and three productivity levels for longleaf and four for loblolly, making a total of 36 possible classes of conversion opportunities.

After the conversion classes were established, Forest Survey plots on private, nonindustrial land in the study area were screened to find those occurring in a hardwood stand on a pine site. (Survey plots are permanently established by the Forest Service at intersections of a 3-mile grid across the Midsouth.) These plots were then classified according to the just mentioned criteria. Since each plot represents from 5,000 to 6,600 acres, its site index and number of hardwood trees over 10 inches were weighted by an appropriate area expansion factor. Average site index and number of hardwood trees 10 inches and over per acre were then derived for each conversion class. Plot expansion factors were accumulated to estimate the acreage in each conversion class.

The screening yielded plots in 31 conversion classes. This number was reduced to 20 (table 2) since classes with less than 15,000 acres were discarded because of excessive sampling error. These deletions left a total of 1.9 million acres, about half of which require planting and half can be regenerated naturally (table 3). Loblolly pine overshadows the other species; 85 percent of the area can be regenerated to loblolly.

Treatments Were Scheduled

All sites are prepared for planting or natural seedfall by heavy machinery, followed by poisoning of the remaining hardwood trees and a preparatory burn. The character of the

Table 2.--*Type conversion classes on private nonindustrial ownerships in western Louisiana, 1974*

Class number	Species	Regeneration	Stand size	Productivity level	Hardwoods 10 in. d.b.h.	Area
					No./acre	*Thousand acres*
1	shortleaf	natural	other	1	4	17.5
2	"	"	"	2	13	62.8
3	"	"	"	3	3	22.0
4	"	"	sawtimber	2	26	61.8
5	longleaf	"	other	3	2	23.0
6	"	planting	"	2	10	28.1
7	"	"	"	3	4	39.1
8	"	"	"	4	6	29.0
9	loblolly	natural	"	1	8	29.1
10	"	"	"	2	15	172.2
11	"	"	"	3	14	133.7
12	"	"	sawtimber	1	32	132.5
13	"	"	"	2	31	188.5
14	"	"	"	3	22	68.6
15	"	planting	other	1	18	33.9
16	"	"	"	2	12	214.9
17	"	"	"	3	14	396.7
18	"	"	sawtimber	1	36	22.0
19	"	"	"	2	37	50.4
20	"	"	"	3	33	133.8
All classes						1,859.6

Table 3.--*Type conversion opportunities on private nonindustrial ownerships in western Louisiana by species and type of regeneration*

Species	Type of regeneration		Total
	Natural	Planting	
	Thousand acres		
Shortleaf	164.1	...	164.1
Longleaf	23.0	96.2	119.2
Loblolly	724.6	851.7	1,576.3
All species	911.7	947.9	1,859.6

hardwood overburden on these sites makes intensive site preparation necessary.

In naturally regnerated stands, seed trees are harvested after seedlings become established--usually 3 years for loblolly, 4 for shortleaf, and 5 for longleaf pine. Precommercial thinning of shortleaf and loblolly stands is done when the stand is about 3 years old. Longleaf stands are not thinned.

The planting density for areas to be regenerated artificially is 680 trees per acre. This spacing is a compromise between a wide one for sawtimber and a close one for pulpwood.

In both naturally regenerated and planted stands, prescribed burning begins when the stands are 15 years old and is repeated every 4 years for hardwood control and fire hazard reduction. Longleaf stands are also burned after seed tree removal and before height growth starts to control brownspot disease.

After the first harvest cut, a seed source is left in all stands. For loblolly and shortleaf pine, a residual of 10 ft^2 of basal area per acre is left as seed trees. Longleaf pine is reproduced under a shelterwood with a density of 30 ft^2 per acre (Croker and Boyer 1975). All sites are burned to prepare the seedbed.

Economic Values Were Determined

All yields, prices, and costs were assumed known and not subject to variation since the incorporation of risk and uncertainty is beyond the scope of this analysis.

Yield models from Schumacher and Coile (1960) were used to predict yields of natural stands. The plantation yield model of Lenhart (1971) was selected for loblolly pine, and that of Lohrey and Bailey (in press) for longleaf.

Stumpage prices were calculated at $6.53 per cord, or 8 cents per cubic foot, for pulpwood and $53.69 per thousand board feet (International ¼-inch rule) for sawtimber. These prices were derived from figures published by the Louisiana Department of Agriculture (1974). Costs are listed in table 4. Land values and taxes were not included.

Net present value was chosen as the investment criterion. Net present values were calculated for each class using a 6 percent interest rate. In calculating these values, rotation age for plantations was set at 30 years, and it was assumed that plantations would be followed by a continuing series of natural stands. For natural stands, rotation age was set equal to the age when net present value is maximum, subject to the restriction that minimum rotation age would be at least 40

Table 4.--*Cost of forest practices*[1]

Practice	Cost
	- - *Dollars* - -
Site preparation	45.49/acre
Tree injection	0.25/stem
Burning during conversion	3.50/acre
Planting	
Seedlings	9.50/thousand
Planting cost	20.67/acre
Burning for hardwood control	1.50/acre
Precommercial thinning	12.00/acre

[1] Costs derived in part from Sunda and Lowry 1975.

years to ensure reliable seed production. In natural stands, the first rotation is followed by a perpetual series of natural stands. Incorporating an infinite time horizon insures that the net present values of investments with different rotation lengths are comparable.

Conversion Classes Were Ranked

The classes were then ranked by parametric linear programming (Murphy 1976b). The initial funding for type conversion is set to a low figure so that only one class will be selected. Then the parametric linear programming procedure is invoked, and the funding level is increased. Net present value is maximized. As the funding level increases, more classes can be funded, and they are selected one by one. The order in which they enter the solution determines their rank. Then, no matter how much money is available, the best selection can be made based upon these rankings.

RESULTS

The total cost for type conversion would be $126 million (table 5). The ranking of the type conversion opportunities indicates which gives the most return per dollar expended. However, these rankings are for western Louisiana as a whole, and offer little guidance to the allocation of money to specific localities.

The parishes with the greatest economic potential for type conversion have to be identified. The economic potential of a parish is related not only to the net present values of its conversion opportunities on a per acre basis but also to the

Table 5.--*Ranking of type conversion opportunities for western Louisiana, 6 percent interest rate*

Rank	Class number	Cumulative cost	Cumulative area planted	
			Longleaf	Loblolly
		Thousand dollars	*Thousand acres*	
1	9	1,484		
2	12	9,035		
3	13	19,730		
4	10	28,812		
5	14	32,550		
6	11	39,568		0.0
7	15	42,301		33.9
8	18	44,174		55.9
9	1	45,049		55.9
10	2	48,329		55.9
11	4	51,759		55.9
12	19	56,061		106.3
13	16	73,064		321.2
14	3	74,158		321.2
15	20	85,447		455.0
16	17	117,032	0.0	851.7
17	6	119,241	28.1	851.7
18	5	120,380	28.1	851.7
19	7	123,395	67.2	851.7
20	8	125,646	96.2	851.7

acreage available. These two attributes must somehow be combined to rank the parishes. These two attributes were combined in the following manner.

It has been previously established that the ranking of classes is in descending order of the ratio of net present value to conversion cost (Murphy 1976b). This ratio was calculated for each class in table 5 and was then multiplied by each parish's acreage in that class. The weighted ratios for all conversion classes within a parish were then added, and the parishes were ranked (table 6).

The high ranking parishes have large acreages of high productivity that can be converted to loblolly pine, mainly by

Table 6.--*Ranking of western Louisiana parishes according to type conversion opportunities*

Parish	Total of weighted value-cost ratios	Rank
Allen	33	18
Beauregard	52	16
Bienville	101	8
Bossier	39	20
Caddo	44	17
Calcasieu	66	15
Caldwell	33	19
Claiborne	261	1
De Soto	80	11
Evangeline	77	12
Grant	70	13
Jackson	67	14
Jefferson Davis	28	21
La Salle	- 15	24
Lincoln	110	7
Natchitoches	124	5
Ouachita	0	22
Rapides	94	9
Red River	- 4	23
Sabine	167	3
Union	116	6
Vernon	172	2
Webster	137	4
Winn	81	10

natural regeneration. These are the classes that had high rankings in table 5. Low ranking parishes include those containing portions of the Mississippi Delta and those crossed by the Red River, which has extensive bottom lands. These factors tend to reduce the amount of acreage suitable for type conversion and, hence, the relative importance of these parishes for type conversion. Still other parishes in southwestern Louisiana contain large areas which could be converted to longleaf pine, and these conversion classes were low in rank (table 5).

As yet the only restriction considered has been funding level, but other limitations such as manpower, equipment, and nursery capacity can affect the distribution of funds to parishes. These restrictions as well can be handled by linear programming, as the following example shows.

The total acreage that could be converted to pine by planting is 948,000 acres. Assuming a planting density of 680 trees per acre, the total number of seedlings required for this sort of enterprise would be 645 million. Even if type conversion by planting were spread over a long period of time, existing nursery capacity could not begin to supply the requirements.

A realistic alternative is to limit the amount of acres that can be converted by planting. Linear programming has the power to handle these and other constraints. For this example, the amount that could be regenerated to loblolly by planting was limited to 7,200 acres, and it was assumed that no longleaf would be planted. This problem was then solved with the parametric linear programming procedure.

With the limitation of 7,200 acres for planting, rankings for the conversion classes change, and funds needed for type conversion drop 60 percent (table 7). These results were then used to calculate indices for ranking the parishes. The 7,200 acres in the one planting class were prorated over the parishes having acreage in this conversion class. The resultant parish rankings (table 8) did not change much from the previous one.

Using the results from table 6 or table 8, administrators of cost-sharing programs could designate certain parishes as program participants. The results could also be used to make an initial allocation of cost-share monies to the selected parishes.

CONCLUSION

This procedure enables decisionmakers to allocate cost-sharing funds effectively on a regional basis. It can identify priorities even when several restrictions exist, and it ranks

Table 7.--*Ranking of type conversion opportunities with nursery capacity as a constraint*

Rank	Class number	Cumulative cost	Cumulative area planted	
			Longleaf	Loblolly
		Thousand dollars	*Thousand acres*	
1	9	1,484		
2	12	9,035		
3	13	19,730		
4	10	28,812		
5	14	32,550		
6	11	39,567		0.0
7	15	40,149		7.2
8	1	41,024		7.2
9	2	44,303		7.2
10	4	47,733		7.2
11	3	48,827		7.2
12	5	49,966	0.0	7.2

opportunities according to cost effectiveness, thus aiding in the fulfillment of the intent of programs like the Forestry Incentives Program (FIP).

Efficient allocation of funds is especially important. The initial cost-share allocation for the entire South for 1975 under FIP was about $9.8 million (Anonymous 1975), but many times that amount could be used in western Louisiana for type conversion alone. Hence, that funds be shared where they offer the greatest return takes on a new importance.

Table 8.--*Ranking of western Louisiana parishes according to type conversion opportunities with nursery capacity constraints*

Parish	Total of weighted value-cost ratios	Rank
Allen	31	21
Beauregard	73	11
Bienville	93	9
Bossier	38	18
Caddo	49	17
Calcasieu	70	12
Caldwell	31	20
Claiborne	258	1
De Soto	83	10
Evangeline	70	14
Grant	68	15
Jackson	58	16
Jefferson Davis	34	19
La Salle	0	23
Lincoln	102	7
Natchitoches	105	5
Ouachita	2	22
Rapides	102	6
Red River [1/]	...	...
Sabine	164	3
Union	98	8
Vernon	177	2
Webster	126	4
Winn	70	13

[1/] None of the conversion classes in Red River Parish were selected because of the nursery capacity restraint.

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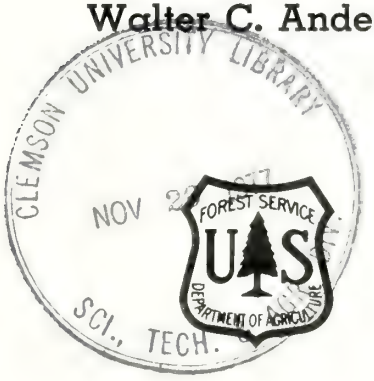
APPRAISING SOUTHERN PINE PULPWOOD STUMPAGE

Walter C. Anderson



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1976

Appraising Southern Pine Pulpwood Stumpage

Walter C. Anderson

SUMMARY

Forest economists have developed a new set of equations for estimating pulpwood stumpage prices in the South. Because advances in harvesting and processing technology cause continuous changes in pulpwood stumpage prices, it is periodically necessary to update analyses of pulpwood price determinants. In this updating (1969-1973), multiple regression analysis was used to determine the variables that had the greatest impact on prices paid for southern pulpwood. The analysis was based on prices actually paid for pulpwood stumpage in southern National forest sales.

Three price zones were delineated and a separate estimating equation was developed for each. Two areas stood out as distinctly different from the others: Florida and South Carolina National forests (highest) and the Ouachita National Forest in Arkansas (lowest); the remaining forests—the Ozark National Forest in Arkansas and National forests in Alabama, Georgia, Louisiana, Mississippi, and Texas—were grouped together into one price zone.

For all price zones combined, the most important variable was the average annual price of delivered softwood roundwood pulpwood. No specific stand characteristics emerged as dominant influences on pulpwood stumpage prices in the analysis, but prices appeared to rise with increases in acreage, volume per acre, trees per acre, and volume per tree. No independent variable was common to all three equations. R^2 values ranged from .29 to .62 and standard errors from 1.84 to 3.19. The equations are suitable for estimating the price of publicly owned timber and are adequate guides to private stumpage prices as well.

Additional keywords: Price, estimating equation, price determinants.

More stumpage is sold for pulpwood than for any other southern pine roundwood product. For the past two decades, the proportion of southern pine cut for pulpwood has increased so steadily that pulp-

wood now constitutes nearly half of the cubic-foot volume removed from southern forests each year. This upward trend will undoubtedly continue unless a major new source of wood for pulping is found, as was recently true when chips from plant residues became available.

This paper analyzes the price determinants of southern pine pulpwood stumpage in National forests in eight States. The present study updates to 1973 previous work by Row and Guttenberg (1961), Fasick and Sampson (1966), and Anderson (1969). Periodic updating is necessary as advances in harvesting and processing technology bring about changes in stumpage price relationships. Since the mid-1960's, the industry has experienced substantial increases in mechanized pulpwood harvesting, tree-length logging, and wholetree chipping. Moreover, widespread use of chipping headrigs has expanded the demand for small trees and the pulpwood-size sections of larger ones, since chipping headrigs make it possible to produce valuable lumber from small logs previously suitable only for pulpwood. Consequently, what formerly would have been pulpwood sales are now often multiple-product sales, which bring high stumpage prices. In the present study, new equations were developed to estimate fair prices for standing timber based on prices actually paid for similar tracts. The equations, which include measures of stand conditions and other factors influencing stumpage prices, apply only to lump sum sales.

Data

Prices were analyzed for 362 southern pine pulpwood stumpage sales from National forests between 1968 and 1973:

Year	*Number of Sales*
1968	47
1969	69
1970	81
1971	67
1972	50
1973	48

All were commercial sales that had been competitively priced. The number of sealed bids per sale varied from one to eight, the average being two. Sales with more than 10 percent hardwood by volume were excluded, as were negotiated and special sales such as timber on rights-of-way. There was no limit on sale size, which ranged from

27 to 1,844 acres. The average sale area was 440 acres. Numbers of sales by State were:

Alabama	23	Louisiana	8
Arkansas	103	Mississippi	51
Florida	74	South Carolina	32
Georgia	26	Texas	45

For each sale, the information compiled included National forest and ranger district, month and year of sale, number of bids, dollar amount of the winning bid, acreage cut, number of trees, and volume sold. Volumes were reported in cords during the early years of the study but were later expressed in hundred cubic feet (CCF). Therefore, it was necessary to convert all volumes to CCF on the basis of 76 cubic feet of solid wood per cord.

Analysis

Variables

Stumpage prices for individual sales vary with location, time of sale, and stand conditions.

Location.—In recognition of differences in prices within the South, southern National forests were separated into price zones. Factors considered in the groupings were number of bids, volume per tree, and trees per acre. Two areas stood out as distinctly different from the others: Florida and South Carolina National forests reported the highest prices, and the Ouachita National Forest in Arkansas the lowest. The remaining forests—the Ozark National Forest in Arkansas and National forests in Alabama, Georgia, Louisiana, Mississippi, and Texas—were grouped together. Average stumpage price and number of sales for each price zone were:

Price zone	*Average stumpage price*	*Number of sales*
	($ per CCF)	
Florida and South Carolina	13.4 ± 5.1	106
Alabama, Arkansas (Ozark NF), Georgia, Louisiana, Mississippi and Texas	7.6 ± 3.1	171
Ouachita National Forest (Ark.)	6.7 ± 2.8	85

Separate predicting equations were calculated for each price zone.

Time.—During the 6-year period, average annual stumpage prices (in dollars per CCF) for all sales combined were:

1968	$ 7.91	1971	$ 7.48
1969	8.70	1972	8.84
1970	8.52	1973	13.47

The sharp price increase observed in 1973 occurred on all southern National forests. Several factors contributed to this sudden change. First, the price paid for delivered pulpwood increased by about 10 percent, and stumpage prices typically reacted strongly to this change. Second, an escalating demand for pulpwood brought about a 6 percent increase in the volume of roundwood cut and delivered. Third, numerous chipping headrigs had become part of in-line sawing systems.

Fluctuations in stumpage price levels were accounted for by considering the average annual delivered price of pine roundwood pulpwood in the Midsouth—a published figure—as an index of market behavior in the analysis. Average annual prices of delivered wood for the study period were:

Year	*Average price (per cord)*	*Year*	*Average price (per cord)*
1968	$17.75	1971	$19.12
1969	18.54	1972	20.80
1970	18.81	1973	23.84

The variable was designated: A_1 = average annual price of delivered softwood roundwood pulpwood in the Midsouth (in dollars per standard cord).

Stand characteristics.—Stand characteristics affect pulpwood stumpage prices mainly by influencing harvesting costs. Ten stand characteristics were tested as possible price determinants. Three were obtained directly from the sales records, and seven were generated from the primary data. The variables considered were:

V = volume sold (CCF)
T = number of trees sold
A = acreage cut
V/A, A/V = volume per acre and its reciprocal
V x V A = interaction of total volume and volume per acre
T/A = number of trees per acre
V/T, T/V = volume per tree and its reciprocal

Equations

For each price zone, a separate single-equation model was set up in the form of:

$$P: V + T + A + V/A + A/V + V \times V/A + T/A + V/T + T/V + A_p$$

The dependent variable in the model, identified as P, was stumpage price (in dollars per CCF). From the price model and the collected

sales data, the following price estimating equations were developed for each zone:

Price zone	Estimating equation	R^2	SE
Florida and South Carolina	$P = -39.5796 + 2.3663\ A_p + 0.0024\ A + 0.4532\ V/A + 16.7093\ A/V$	0.62	3.19
Alabama, Arkansas (Ozark NF), Georgia, Louisiana, Mississippi and Texas	$P = -6.6919 + 0.6895\ A_p - 9.4816\ T/A + 0.0205\ V/T$	0.29	2.60
Ouachita National Forest (Ark.)	$P = -20.7655 + 1.3378\ A_p + 2.8767\ A/V$	0.56	1.84

Factors Related to Price

For all price zones combined, a total of five independent variables were significant. The average annual price of delivered softwood roundwood pulpwood (A_p) was the most important factor in each prediction equation. This variable alone explained 58 percent of the price variation for Florida-South Carolina and 53 percent for the Ouachita National Forest. However, this factor explained only 14 percent of the price variation for the price zone comprised of the other Southern States.

It is impossible to generalize about the relationship of stand conditions to pulpwood stumpage prices on the basis of the present analysis. In the equations, prices tended to rise with increases in acreage, volume per acre, trees per acre, and volume per tree. No independent variable, however, was common to all three equations, and only one, A/V, appeared in two of them.

Application

Application of the predicting equations is relatively simple. To estimate the price of pine pulpwood timber in the Ouachita National Forest, it is necessary to know only average volume per acre; for application in Florida or South Carolina, a knowledge of the acreage is also required; for stands in Alabama, Arkansas (Ozark NF), Louisiana, Mississippi, and Texas, it is necessary to know the number of trees per acre and average volume per tree. This information is normally collected when a sale is being prepared. These stand values together with the delivered price of pulpwood are substituted in the equation to calculate the price of pulpwood stumpage.

A sample calculation can be illustrated by the problem of determining the value of timber in 1973 in a Florida tract where the area

cut is 400 acres, and the volume per acre is 600 cubic feet. When these values are entered into the Florida-South Carolina estimating equation, the result is:

$$P = -39.5796 + 2.3663(23.84) + 0.0024(400) + 0.4532(6) + 16.7093(0.1667)$$
$$P = \$23.30$$

This is the estimated price in 1973 (in dollars per CCF) for a tract of timber in Florida with the characteristics that have been described. The estimated price is comparable to the amount paid for other stands sold in the Florida-South Carolina price zone.

Setting a Minimum Price

Since there is not always competitive bidding in stumpage purchases, a minimum price must be set to satisfy both legal and practical requirements. Otherwise, valuable public timber might be sold at prices below market value. This can occur when offers attract only one bid. Even where there is more than a single bidder, a minimum price is necessary as protection against possible collusion among buyers.

There is no fully satisfactory way to determine the minimum acceptable price, i.e., one that is high enough to protect the seller's interest but low enough to assure that the timber will be sold and that loggers will remain in business to compete for timber in future sales. The seller should not use the calculated value as his reserve price for the timber, since there is only about a 50 percent chance that the tract will be sold at this price or higher. A simple way to derive the reserve price is to subtract an amount equivalent to one standard error at the mean (expressed as a percent) from the estimated price. For a tract where the characteristics of the timber are average, 80 to 90 percent of the offers should be above the reserve price set in this way.

Application of the Equations To Private Timber Sales

The analysis presented here was based entirely on National forest sales. The applicability of the results to private sales was not tested primarily because records from private sales of pulpwood are fragmentary.

National forest sales are not typical of all pulpwood sales. They are normally larger than private ones, although the range in size may overlap. National forest sales also differ from private ones in that the minimum acceptable price in a private sale may be known only to the seller; whereas in public sales a minimum price must be advertised with the offer to sell.

Nevertheless, prices paid for National forest stumpage do not differ greatly from those paid for private stumpage. National forest timber is not overpriced because relatively few bidders are attracted by the large blocks normally sold, and the availability of timber from private sources puts an upper limit on the prices buyers need to pay. National forest timber is never underpriced because sellers of public stumpage are not compelled to complete transactions at less than the firm minimum price advertised. Since both public and private stumpage are subject to the same market and production influences, the price variables found significant for public sales are applicable to private sales. Product prices affect the price of all stumpage regardless of ownership, and stand conditions that determine logging costs should also affect all stumpage prices similarly.

Conclusion

Results from this analysis are adequate guides to pulpwood stumpage prices in the shortrun, but changes are occurring that will have longrun influences on prices. The ratio of capital to labor in pulpwood harvesting is rising in response to the adoption of increasingly sophisticated machines. As processing techniques continue to improve, high-value products are being manufactured from small-diameter logs. Also, efforts are underway to create a chip export market in the South. Changes such as these will both influence stumpage price levels and alter the relationship of stand characteristics to price.

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1976. Appraising southern pine pulpwood stumpage. South. For. Exp. Stn., New Orleans, La. 7 p. (USDA For. Serv. Res. Pap. SO-129)

Pulpwood stumpage prices from 362 National forest sales made between 1968 and 1973 were influenced by volume per tree, volume per acre, trees per acre, and acres sold; but most important was the price of delivered pulpwood. Combinations of factors influencing prices differed by the three zones into which prices were classified. Together the factors accounted for 29 to 62 percent of the price variation by zone.

Additional keywords: Price, estimating equation, price determinants.

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Forest Service Research Paper SO-130

Performance of Stained, Rough-Sawn Southern Pine Siding—A 10-Year Evaluation

CHARLES W. McMILLIN

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Southern Forest Experiment Station
Forest Service
U.S. Department of Agriculture
1976

SUMMARY

Southern pine performs well as a siding material in hot, humid climates if proper procedures are followed in manufacturing and installing it. Such is the conclusion of a 10-year test of stained, rough-sawn southern pine tongue-and-groove siding applied to the east and west exposures of a large building (22 feet high at the ridge) in central Louisiana.

Specifications differed somewhat from those for standard siding. Of particular importance was the longer tongue and groove (3/8-inch), the 7/8-inch thickness, two grooves in the back, and the low equilibrium moisture content (9 percent) at application.

Half the boards in each exposure were treated with a water-repellent solution containing pentachlorophenol. All were then dipped in a russet color, penetrating oil-base stain; a second coat was brush applied after installation over 3/8-inch southern pine plywood sheathing. The full-length siding was fastened to horizontal girts on 2-foot centers with three 2-1/8-inch-long annularly grooved stainless steel nails. After 60 months of very satisfactory performance (as evaluated from 50 test locations distributed over each exposure), the siding was refinished with a spray coat of preservative and a single brush coat of stain.

The siding proved fully serviceable after 10 years' exposure to the harsh climatic conditions of Louisiana. There was little difference between the penta-treated and untreated sections. Gap between boards averaged 0.092 inch (gap was 0.015 inch at installation), but the interlocking action of the longer tongue and groove remained effective. Cup warp (measured across the 5-1/8-inch face) averaged 0.06 inch. About 2.3 percent of the nails had withdrawn from the board surface by more than 1/16 inch. Surface checking (measured on a severity rating scale of 0 to 4) averaged 1.5 There was no evidence of decay or mildew. Stain retention and color stability was good.

In this locale a periodic restaining schedule of about 5 to 6 years is indicated; in less severe exposures the rate of stain erosion would probably be even slower.

Additional keywords: Finishing systems, penetrating coatings, checking, nailing, cupping, shrinkage.

Performance of Stained, Rough-Sawn Southern Pine Siding—A 10-Year Evaluation

CHARLES W. McMILLIN

Because of expanding consumer acceptance of rough-textured surfaces, the Wood Utilization Laboratory at Pineville, La., is evaluating the in-service performance of some stained, rough-sawn, southern pine tongue-and-groove siding manufactured and installed by an improved technique. The results reported here are from one installation, observed for a 10-year period.

The siding was tested on the east and west exposures of one of the laboratory's large buildings (fig. 1). The climatic conditions of central Louisiana are hot and humid, and the exposure was severe. The roof overhang is considerable, but its

Figure 1.—Test installation of rough-sawn, southern pine, tongue-and-groove siding. The exposure shown faces the east. Siding was applied August 1966.

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[1] The author is Principal Wood Scientist, Southern Forest Experiment Station, Forest Service--USDA, Pineville, La.

protective effect is largely negated by the height of the wall (22 feet at the ridge).

The performance and appearance of the siding were periodically evaluated by measuring the gap between boards, comparing the degree of stain erosion with a sample that had not been exposed, and noting defects such as mildew, pitch exudation, surface checks, and cupping. Fifty sampling locations were distributed over each exposure.

MANUFACTURE AND APPLICATION

Approximately 3,000 board feet of siding were manufactured in lengths from 10 to 24 feet. The specifications were for:

> 1- by 6-inch, bandsawn, B and better, kiln-dried southern pine with rough face and edge-V on bark side and 3/8-inch center-match tongue and groove; face width, 5-1/8 inches; thicknessed on back only (hit and miss) to 7/8-inch; two grooves 1/4-inch deep by 1/4-inch wide on back side at third points.

These specifications differ slightly from those for standard tongue-and-groove siding. Of particular importance is the longer tongue and groove, the 7/8-inch thickness, and the grooves in the back to minimize cupping.

After the siding had been kiln-dried, it was conditioned to constant weight in a large room maintained at 72° F and 50 percent relative humidity. The resulting average moisture content was 9 percent.

Growth rate and specific gravity (ovendry weight and volume at 9 percent m.c.) of the wood were determined by sampling both ends of half the boards. Growth rate averaged 7.7 rings per inch; specific gravity averaged 0.59.

Half the boards for each exposure were dipped for 3 minutes in a water-repellent solution containing pentachlorophenol (Woodlife) and dried for 1 week.[2] All boards were then dipped in stain and allowed to dry on edge. The dark russet stain had a penetrating-oil base and was manufactured by Olympic Stained

[2] Trade and firm names are given for information only and do not imply endorsement by the U.S. Department of Agriculture. Similar products are available from sources other than those mentioned.

Products Company. It was heavily pigmented and contained a fungicide.

The siding was applied vertically over 3/8-inch southern pine plywood sheathing. It was used in full lengths, i.e., without end joints. It was fastened to horizontal girts placed on 2-foot centers, each board being fixed to each girt with three nails. Nails were of stainless steel, 2-1/8 inches long, annularly grooved, and had blunt points. Figure 2 shows a section of the exterior wall construction.

A second coat of stain was brushed on all boards after installation.

PERFORMANCE

Thirty Months

Stability (gap between boards) was excellent. The gap at time of installation had averaged 0.015 inch; 30 months later it

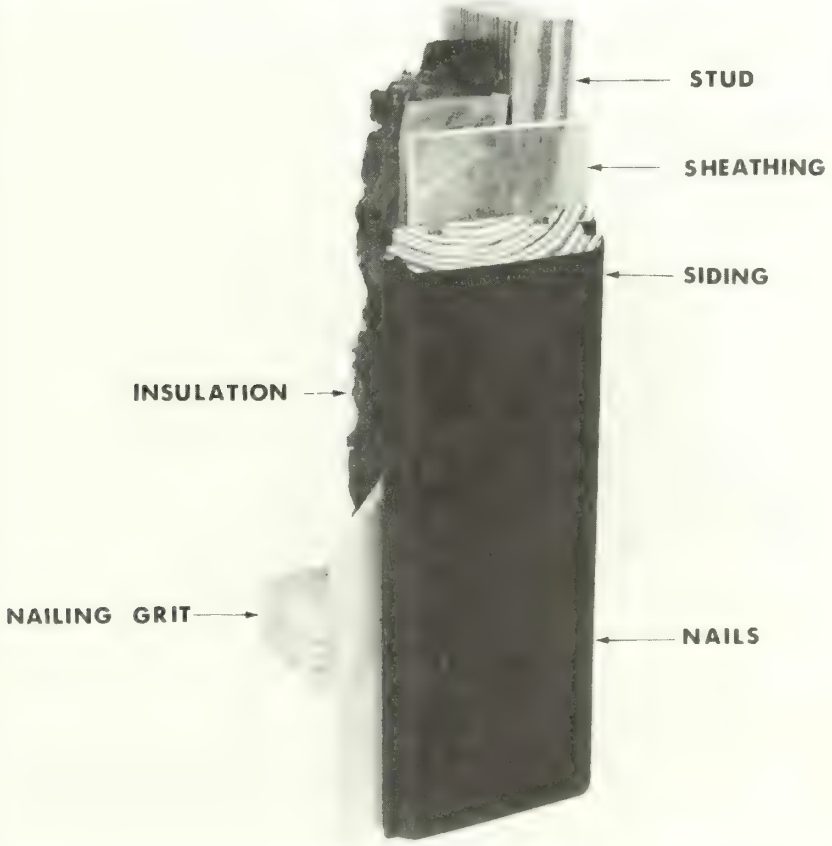

Figure 2.--Exterior wall section illustrating construction method.

was still small. The average gap increased during the summer, but it never exceeded 0.040 inch. Since the tongue was stained, this amount was not visually noticeable. There was no appreciable difference between the stability of boards treated with the water-repellent preservative and those not treated.

The boards dipped in the water-repellent solution looked better than those not dipped. Although the undipped boards were entirely acceptable after 2-1/2 years, they exhibited a somewhat greater degree of stain erosion. There were no apparent differences in erosion rates or appearance between boards on east and west exposures.

Surface checking was minor; very little was in evidence on the repellent-treated siding. Pitch could be detected in a few locations, but it was not considered sufficient to detract from the overall appearance. There was no evidence of nail withdrawal, shelling, warp, cup, mold, stain, or decay.

The superior stability of the siding is attributed, in great part, to its low and uniform moisture content at time of installation. The 2-foot center distance between nailing girts and the firm support provided by the southern pine plywood sheathing were also advantageous.

Sixty Months

After 5 years of exposure, the average gap between boards was about the same as after 30 months' exposure (0.040 inch maximum). Surface checks were present to varying degrees at most sampling locations but were not considered objectionable. There was no indication of mold, stain, or decay. As after 30 months' exposure, the boards dipped in the water-repellent solution looked somewhat better than those not dipped, but both retained their distinctive russet color.

Although stain erosion had not progressed to a point where restaining was absolutely required, it was decided to refinish the test installation at this time. Loose nails were removed, and new ones were driven about 1/2-inch from the original location. The entire surface was then lightly dusted with a steel brush to remove loose stain and debris. The water-repellent penta solution was applied to the appropriate test sections with a hand-held, 5-gallon, pump-up-type garden sprayer. (Protective clothing and masks are needed when using this procedure. It is also advisable to protect grass and plants from possible damage.) After a 1-day solvent evaporation period, a single coat of the same stain was brushed on all sur-

faces. Care was taken to apply stain to the tongue areas and V-grooves between boards. The overall procedure was felt to be simple, inexpensive, and efficient.

One-Hundred-Twenty Months

After 10 years' exposure to the harsh climatic conditions of central Louisiana, the siding remained fully serviceable, although additional weathering effects were evident.

For practical purposes, there was little difference in appearance and degree of stain erosion between boards treated with the water-repellent solution and those not so treated. This result suggests the treatment is more effective during the initial stages of weathering. No test location showed evidence of decay or mildew. Color stability was good for both east and west exposures. As expected, some flaking was noted on smooth bevel edges, but erosion of stain from the rough-sawn faces had not progressed to a point where refinishing must necessarily be considered.

The average gap between boards increased to 0.092 inch, but the interlocking action of the long tongue and grooves remained effective. Exposed portions of the tongue generally retained an adequate coating of stain. Cup warp (measured across the 5-1/8-inch face surface) averaged 0.06 inch. Only 7 nails (of the 300 nails at the 100 test locations) were withdrawn from the board surface more than 1/16 inch.

For this evaluation, surface checking was measured on a severity rating scale of 0 to 4; typical surfaces are illustrated in figure 3. Average check width and number of checks per face width for each rating were as follows:

Rating	Avg. check width, inch	Avg. number of checks per face width of board
0	0.000	0
1	.005	5
2	.010	8
3	.020	10
4	.035	12

For the 100 test locations, the average surface checking rating was 1.5.

Southern pine should perform satisfactorily in the South if the procedures described here are followed. Although this test

indicated a periodic restaining schedule of about 5 to 6 years, the rate of stain erosion and surface deterioration may be considerably reduced in less severe exposures.

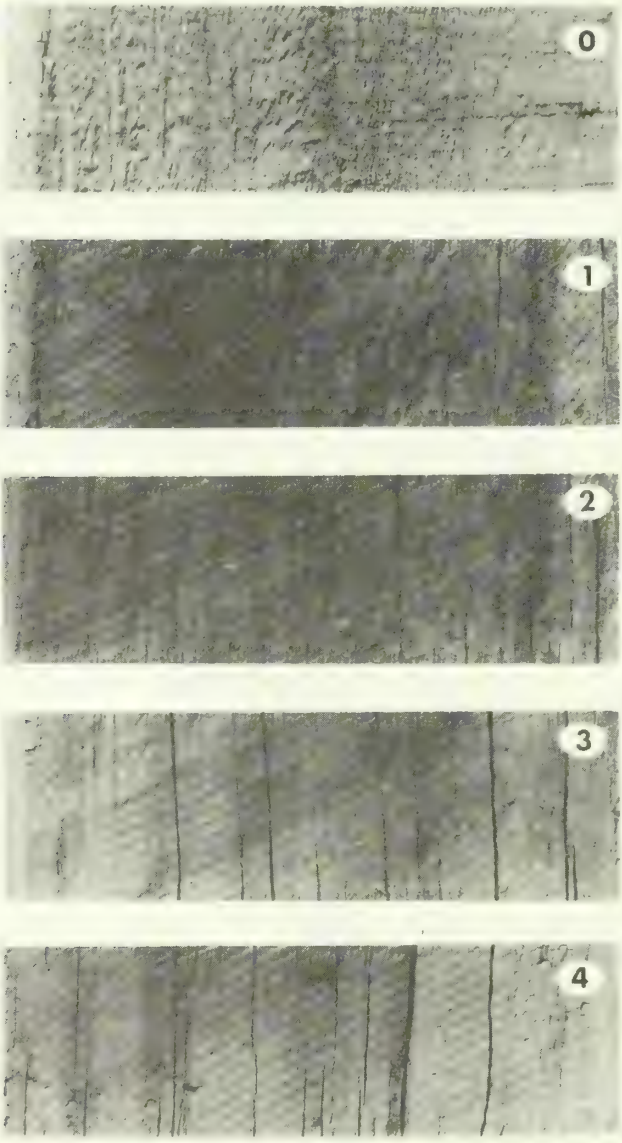

Figure 3.--Illustrative surfaces used to rate severity of checking. A rating of 0 indicates no checking; a rating of 4 indicates severe checking.

McMillin, Charles W.
1976. Performance of stained, rough-sawn southern pine siding--a 10-year evaluation. South. For. Exp. Stn., New Orleans, La. 8p. (USDA For. Serv. Res. Pap. SO-130)

Southern pine performs well as a siding material in hot, humid climates if proper procedures are followed in manufacturing and installing it.

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Tree Sizes Harvested In Different Thinnings - - Another Look

W. F. MANN, JR., AND D. P. FEDUCCIA

Southern Forest Experiment Station

SUMMARY

In studies with loblolly and slash pine plantations, thinning increased the number of sawtimber-sized trees slightly; but it also markedly increased the number of 4- to 7-inch trees that had to be logged during the rotation. Handling large numbers of small trees can be costly.

The loblolly pine was planted on a good site at 10- by 10-foot spacing and thinned to residual basal areas of 70 (heavy), 85 (moderate), or 100 (light) square feet per acre every 5 years from age 20 to 45. Check plots were not thinned.

With an assumed rotation age of 30 years, total trees cut (those removed in thinnings plus those in the final harvest)≥10 inches dbh ranged from 128 per acre on checks to 174 on moderately thinned plots. Total stems cut in the 4- to 7-inch classes ranged from 38 per acre on checks to 80 per acre on moderately thinned plots. As rotation length was increased, the number of large stems rose slightly for all treatments, but differences among treatments stayed nearly constant from age 30 to 45. However, the differences between checks and thinning treatments in number of small stems became more pronounced. Thinned plots produced about the same number of small stems regardless of rotation age, but on checks the number of small stems decreased as they grew into the larger diameter classes. Thus, by age 45 checks had only 6 small stems per acre, but moderately thinned plots had produced 76.

Average diameter of all trees—including those removed in thinnings—was always larger for unthinned than for thinned plots. Trees on check plots averaged 10.4 inches dbh at age 30 and 13.0 inches at age 45. Those on moderately thinned plots averaged 9.7 inches at age 30 and 11.0 inches at age 45.

Sawtimber volumes on checks were comparable to those on heavily thinned plots but somewhat lower than those on light- and medium-thinned plots. The difference between the checks and the best of the thinning treatments was only about 800 board feet per acre at age 30 and 2,500 board feet per acre at age 45. Checks had many trees just below sawtimber size; given a few more years for ingrowth into the sawtimber classes to be completed, volumes on checks would probably compare favorably with those on thinned plots.

Similar trends in diameter distribution, average diameter, and sawtimber production were observed in slash pine planted at 6- by 7-foot spacing on an excellent site and thinned every 5 years from age 17 to residual densities of 70, 85, or 100 square feet per acre.

Thinnings plus the final cut at age 32 yielded from 133 stems per acre≥10 inches dbh on checks to 156 stems on lightly thinned plots. Total cut of 4- to 7-inch trees ranged from 176 stems per acre on the checks to 375 on heavily thinned plots.

Average diameter of all trees harvested was 7.7 inches on plots thinned heavily and 8.5 inches on check plots. Net board-foot production to age 32 was highest on light thinnings (14,673 bd. ft. per acre) and lowest on checks (12,069 bd. ft. per acre).

Thus, in both these studies comparable volumes of sawtimber were obtained from thinned plots and from checks, but many more stems had to be cut on the thinned plots. The landowner should consider the effect this abundance of small trees may have on his logging costs when he is deciding whether to thin. Of course, many other considerations including the cost of marking and supervising thinning operations, the short-term returns available from thinning, and thinning's effect on disease and insect problems will also enter into his decision.

Additional keywords: Diameter distributions, average diameter, *Pinus taeda*, *Pinus elliottii*.

ERRATA SHEET

Tree Sizes Harvested in Different Thinnings--Another Look

by

W. F. Mann, Jr., and D. P. Feduccia

Page 5, column B, line 1 should read as follows:

"intensity of thinning from 268 to 369 per acre."

Figures 1 and 2 are reversed and should be replaced with the following:

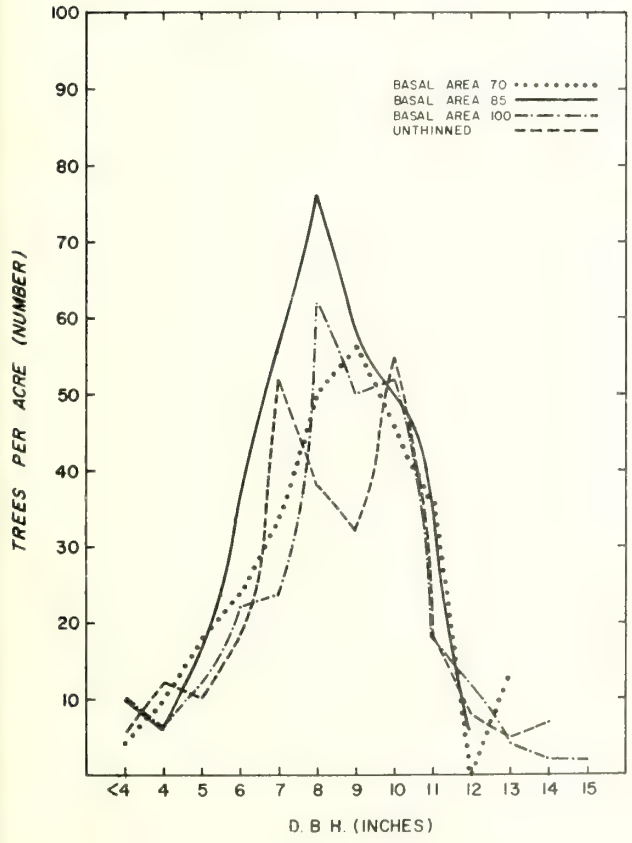

Figure 1.
Diameter distributions of loblolly pine before first thinning at age 20.

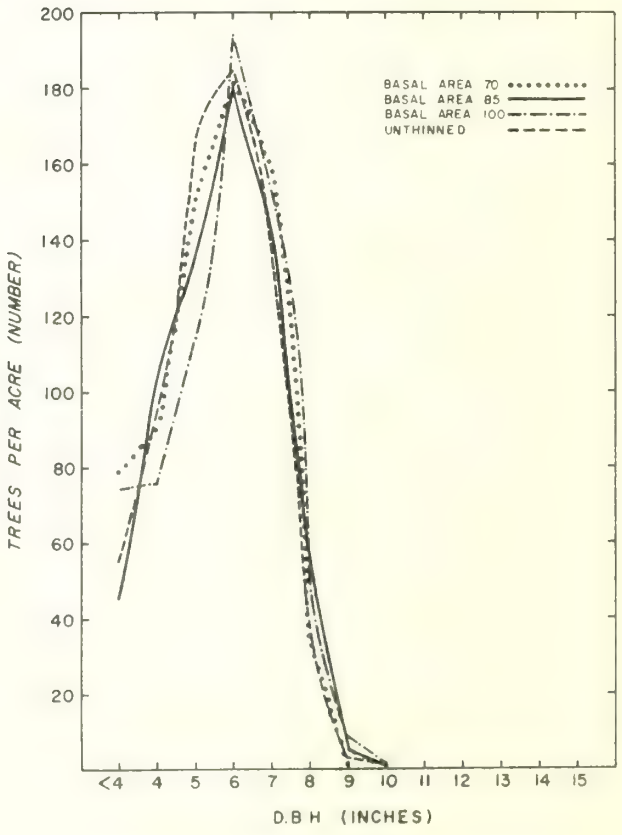

Figure 2.
Diameter distributions of slash pine at age 17 before the first scheduled thinning.

Tree Sizes Harvested In Different Thinnings - - Another Look

W. F. Mann, Jr., and D. P. Feduccia[1]

Thinning boosts diameter growth of the better trees in a stand and increases the diameter of crop trees removed in the final harvest. However, many small trees that may be uneconomical to log must be removed to achieve the gain in diameter growth. To assist landowners in appraising this factor when choosing a thinning regime, diameter distributions of trees removed in intermediate cuttings as well as the final harvests are summarized. Data for several rotation lengths were taken from plots in loblolly *(Pinus taeda* L.) and slash *(P. elliottii* Engelm.) pine plantations that were either thinned to different residual densities or not thinned.

THE PLANTATIONS

Loblolly Pine

Data were collected from a stand planted in 1928 at a 10- by 10-foot spacing in central Louisiana. Site index averaged 86 feet at age 50. Thinnings to residual basal areas of 70 (heavy), 85 (moderate), and 100 (light) square feet per acre were started at age 20 and repeated every 5 years to age 45. Thinnings were mainly from below, but large defective stems and trees in upper crown classes were removed to relieve crowding. Unthinned checks were also established and measured along with the other plots each time a thinning was made. There were five 0.4-acre plots for each thinning treatment and four for the check.

Survival at age 20, the earliest documentation available, averaged 64 percent and ranged from 59 percent on the checks to 74 percent on plots thinned moderately. Diameter distributions varied somewhat; the moderate thinnings had the most trees per acre in all but the few smallest and largest diameter classes (fig. 1). In addition, checks had 23 to 25 fewer trees per acre in the 8- and 9-inch classes than the other treatments, which may explain lower sawlog volumes at later ages.

Measurements included diameter at breast height of all trees, and merchantable length of bole to a 4-inch top (outside bark) and total height of sample trees. To age 30, local volume tables were constructed. Thereafter, volumes were determined by height accumulation.[2]

Stand data given are based on the assumption

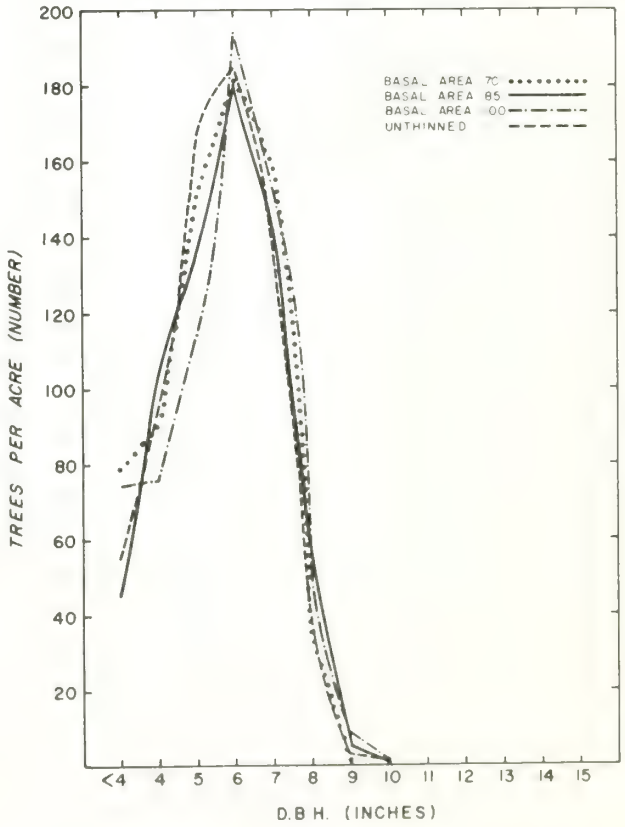

Figure 1.
Diameter distributions of loblolly pine before first thinning at age 20.

[1] W. F. Mann, Jr., is Chief Silviculturist, Southern Forest Experiment Station, Forest Service — USDA, Pineville, La.; D. P. Feduccia is Research Forester, Louisiana Forestry Commission, assigned to the Southern Forest Experiment Station, Forest Service — USDA, Pineville, La.

[2] Lohrey, R. E., and T. R. Dell. 1969. Computer programs using height accumulation for tree volumes and plot summaries. J. For. 67: 554-555.

that residual stands were clearcut at 30, 35, 40, or 45 years. A theoretical, longer rotation was not possible because the plantation was destroyed at age 47 by tornado-like winds.

Slash Pine

To help determine if the wide initial spacing in the loblolly plantation affected results, a similar analysis was made of slash pine planted at a much higher density than the loblolly. Suitable data were not available for loblolly.

The slash plantation was established in central Louisiana in 1942 on a cutover site with an index of 100 feet at age 50. Spacing was 6 by 7 feet. A very light thinning at age 16 removed small, suppressed trees for fence posts. Numbers and volumes of trees cut were determined from stumps on each plot and were combined with data for the first scheduled thinning at age 17. On the check plots, trees removed at age 16 are tabulated as cut trees.

Thinnings were repeated at 5-year intervals after age 17. Residual densities were the same as for loblolly –70, 85, and 100 square feet per acre. As with loblolly, thinning was primarily from below. A check was also included. All treatments were replicated four times on 0.92-acre plots.

Before the first thinning, stocking was about the same among all treatments, ranging from 667 to 723 trees per acre. The number of stems by diameter classes was similar for all treatments; lightly thinned plots deviated most from the averages (fig. 2).

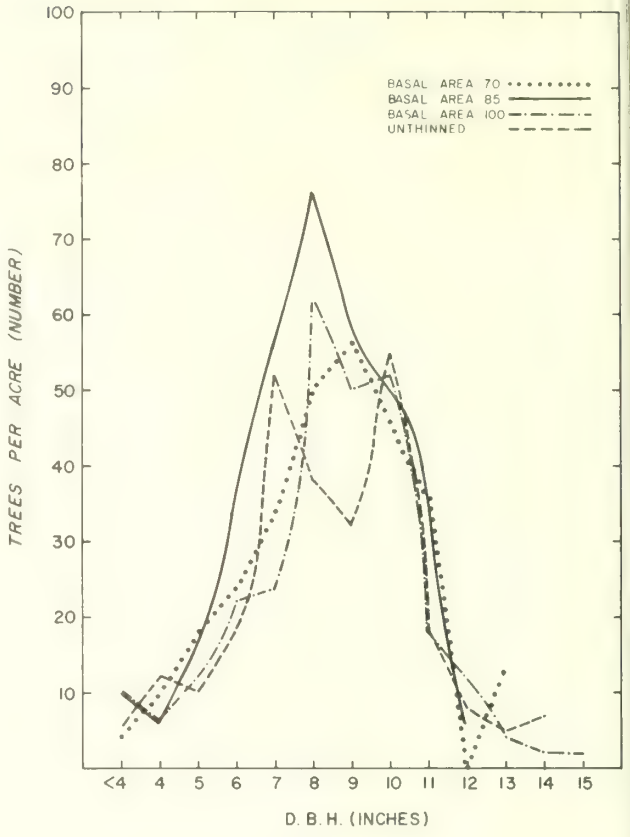

Figure 2.
Diameter distributions of slash pine at age 17 before the first scheduled thinning.

Measurements and computations were the same as those described for loblolly, and height accumulation was used for volume determinations.

Table 1. — *Loblolly pine trees per acre removed in two thinnings and standing at age 30 years, by 1-inch dbh classes and thinning treatments*

Thinning treatment; no. of stems cut and standing	Diameter class — inches															
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18+	Total
	Number															
BA-70																
Cut at 20 and 25 yrs.	2	14	14	16	28	22	26	20	2	6	2	2	0	0	0	154
Standing at 30 yrs.	0	4	0	2	12	8	22	20	22	24	6	2	4	0	0	126
Total stems	2	18	14	18	40	30	48	40	24	30	8	4	4	0	0	280
BA-85																
Cut at 20 and 25 yrs.	2	12	24	34	32	12	22	24	2	2	0	0	0	0	0	166
Standing at 30 yrs.	2	0	2	4	10	26	26	40	32	16	8	2	0	0	0	168
Total stems	4	12	26	38	42	38	48	64	34	18	8	2	0	0	0	334
BA-100																
Cut at 20 and 25 yrs.	4	10	14	10	14	18	6	8	6	2	2	0	0	0	0	94
Standing at 30 yrs.	2	0	0	2	10	28	32	26	28	20	8	2	0	2	2	162
Total stems	6	10	14	12	24	46	38	34	34	22	10	2	0	2	2	256
Unthinned																
Standing at 30 yrs.	8	5	2	23	32	30	25	40	18	30	5	3	2	5	0	228

RESULTS

Loblolly Pine

With a rotation age of 30 years, the maximum difference in number of standing trees 10 inches dbh and larger between the check, light thinning, and medium thinning was 8 per acre (table 1). Plots thinned heavily had 28 fewer standing trees≧10 inches dbh per acre than the check; most of the difference was in numbers of 10- and 11-inch trees. Checks had 30 to 34 more standing trees per acre in the 4- to 7-inch dbh classes than thinned plots. Differences among thinning treatments in number of small trees were negligible.

To evaluate the total harvesting job, we must also consider trees removed in the thinnings at ages 20 and 25. Heavy and medium thinning removed 58 and 50 stems per acre 10 inches dbh and larger, or more than double the number removed by light thinning. Four- to 7-inch trees removed in the two thinnings numbered from 38 per acre on lightly thinned plots to 72 per acre on moderately thinned plots.

At age 30, total trees cut (those removed in thinnings plus those taken in the final harvest)≧ 10 inches dbh ranged from 144 per acre on lightly thinned plots to 174 on moderately thinned plots. The final cut produced the bulk of the sawtimber trees since the intermediate thinnings yielded only 17 to 37 percent of the total large-tree harvest. The checks had the fewest large trees, averaging 128 per acre. The source of most of the differences was numbers of trees in the 10- and 11-inch diameter classes. Total small trees cut over the 30-year rotation was 38, 42, 80, and 52 per acre on unthinned, light-, medium-, and heavy-thinned plots, respectively.

Thus, by age 30 check plots had produced 46 fewer trees per acre in the large diameter classes and 42 fewer trees per acre in the small diameter classes than the most prolific of the thinned plots. As rotation length was increased in 5-year steps, number and stems≧10 inches dbh increased slightly for all treatments, but differences among treatments stayed nearly constant from age 30 to 45 (tables 1-4). However, the difference between checks and thinning treatments in number of small stems became more pronounced. About the same total of small stems was cut (in thinnings plus final harvest) from thinned plots whether the rotation age was 30, 35, 40, or 45 years. But the number of small stems on checks steadily decreased as they grew into larger diameter classes (mortality from suppression was only about 30 trees per acre that contained a total of about 1 cord). By age 35 checks had only 22 small trees per acre (table 2); and by age 45 they had only 6 per acre (table 4), or 70 per acre fewer than the number produced on moderately thinned plots.

Regardless of rotation age, average diameter of all trees—including those removed in thinnings—was always larger for unthinned than for thinned plots (table 5). Trees on check plots were 0.3 inch larger than those on heavily thinned plots at age 30 and 1.6 inches larger by

Table 2. — *Loblolly pine trees per acre removed in three thinnings and standing at 35 years, by 1-inch dbh classes and thinning treatments*

Thinning treatment; no. of stems cut and standing	Diameter class — inches															
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18+	Total
	Number															
BA-70																
Cut from age 20 to 30	2	18	14	18	32	26	34	26	4	10	2	2	0	0	0	188
Standing at 35 yrs.	0	0	0	0	0	6	6	2	20	16	14	12	10	2	2	90
Total stems	2	18	14	18	32	32	40	28	24	26	16	14	10	2	2	278
BA-85																
Cut from age 20 to 30	4	12	26	34	38	18	32	36	6	4	0	0	0	0	0	210
Standing at 35 yrs.	0	0	0	0	4	8	14	14	22	24	12	20	6	0	0	124
Total stems	4	12	26	34	42	26	46	50	28	28	12	20	6	0	0	334
BA-100																
Cut from age 20 to 30	4	10	14	10	16	24	14	10	10	2	2	0	0	0	0	116
Standing at 35 yrs.	2	0	0	0	4	8	18	20	16	32	14	16	6	0	4	140
Total stems	6	10	14	10	20	32	32	30	26	34	16	16	6	0	4	256
Unthinned																
Standing at 35 yrs.	5	0	2	15	28	28	15	22	30	25	28	10	2	0	8	218

Table 3. — *Loblolly pine trees per acre removed in four thinnings and standing at 40 years, by 1-inch dbh classes and thinning treatments*

Thinning treatment; no. of stems cut and standing	Diameter class — inches																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19+	Total
	Number																
BA-70																	
Cut from age 20 to 35	2	18	14	18	32	28	36	26	12	14	4	2	2	0	0	0	208
Standing at 40 yrs.	0	0	0	0	2	2	0	4	8	4	14	10	14	6	4	2	70
Total stems	2	18	14	18	34	30	36	30	20	18	18	12	16	6	4	2	278
BA-85																	
Cut from age 20 to 35	4	12	26	34	40	18	40	40	12	10	4	0	0	0	0	0	240
Standing at 40 yrs.	0	0	0	0	2	0	10	6	10	18	14	10	14	10	0	0	94
Total stems	4	12	26	34	42	18	50	46	22	28	18	10	14	10	0	0	334
BA-100																	
Cut from age 20 to 35	6	10	14	10	20	26	18	18	14	8	2	4	0	0	0	0	150
Standing at 40 yrs.	0	0	0	0	0	6	6	12	14	8	26	16	8	6	0	4	106
Total stems	6	10	14	10	20	32	24	30	28	16	28	20	8	6	0	4	256
Unthinned																	
Standing at 40 yrs.	2	0	0	10	13	22	18	15	35	17	32	8	7	5	0	8	192

Table 4. — *Loblolly pine trees per acre removed in five thinnings and standing at 45 years, by 1-inch dbh classes and thinning treatments*

Thinning treatment; no. of stems cut and standing	Diameter class — inches																
	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20+	Total
	Number																
BA-70																	
Cut from age 20 to 40	2	18	14	18	32	28	36	26	14	14	6	4	6	0	0	0	0	218
Standing at 45 yrs.	0	0	0	0	0	4	0	0	4	2	4	12	6	12	6	8	2	60
Total stems	2	18	14	18	32	32	36	26	18	16	10	16	12	12	6	8	2	278
BA-85																	
Cut from age 20 to 40	4	12	26	34	42	18	40	40	12	12	8	2	2	0	0	0	0	252
Standing at 45 yrs.	0	0	0	0	0	0	2	4	12	10	14	10	4	12	12	2	0	82
Total stems	4	12	26	34	42	18	42	44	24	22	22	12	6	12	12	2	0	334
BA-100																	
Cut from age 20 to 40	6	10	14	10	20	28	22	26	14	8	6	4	0	0	0	0	0	168
Standing at 45 yrs.	0	0	0	0	0	2	2	2	6	10	8	14	24	8	6	2	4	88
Total stems	6	10	14	10	20	30	24	28	20	18	14	18	24	8	6	2	4	256
Unthinned																	
Standing at 45 yrs.	2	0	2	2	5	20	13	15	23	25	20	23	13	8	0	2	4	177

age 45. Lightly thinned plots consistently ranked second in average diameter; and moderately thinned plots always ranked lowest, probably because these plots had the lowest average diameter at age 20 before treatments started.

Since checks had the fewest large trees at all rotation ages, it is logical to expect less sawtimber[3] production on checks than on thinned plots. However, the difference was relatively

Table 5. — *Average dbh of all loblolly pine trees removed in thinnings plus those standing at given ages, by thinning treatments*

Thinning treatment	Assumed harvest age — years			
	30	35	40	45
	Inches			
B. A. 70	10.1	10.7	11.0	11.4
B. A. 85	9.7	10.3	10.7	11.0
B. A. 100	10.3	11.1	11.5	12.0
Unthinned	10.4	11.4	12.3	13.0

[3] Board-foot volume of trees 9.6 inches dbh and larger to a minimum top diameter of 8 inches (o.b.), International ¼-inch rule, is used throughout the paper.

small (table 6). Sawtimber yield at age 30 was only 800 board feet per acre less from unthinned plots than from plots that had the highest yields. At age 45, volume on the checks was about the same as on the heavily thinned plots but 2,500 board feet per acre less than from the light thinning.

Slash Pine

Diameter distributions of slash pine removed in three thinnings plus the final cut at age 32 had many of the same trends as loblolly distributions (table 7). Numbers of trees≥10 inches dbh removed in three intermediate cuttings ranged from 16 to 22 per acre among the three thinning treatments. Large trees assumed cut at age 32 varied from 111 per acre on heavily thinned plots to 134 on lightly thinned plots; on the checks they averaged 133 per acre.

The number of 4- to 7-inch trees removed in the three thinnings varied directly with the intensity of thinning from 268 to 375 per acre. Forty-four small trees were cut on the checks in a fence-post operation at age 16. Total cut of small trees, thinnings plus final harvest, ranged from 176 per acre on the checks to a maximum of 375 on heavily thinned plots.

Assuming all stands were clearcut at age 32, average diameter of all trees harvested was 7.7 inches on plots thinned heavily, 7.8 inches on medium-thinned, 8.0 inches on light-thinned, and 8.5 inches on check plots. Differences should become larger with advancing age if results with loblolly are indicative of future trends.

Net board-foot production to age 32 averaged 13,040, 13,449, 14,673, and 12,069 for heavy, medium, and light thinnings and for the checks. As with loblolly, yields were inversely proportional to degree of thinning and lowest on the checks. The differences between the checks and thinning treatments will probably decrease in the next 5 to 10 years as ingrowth into the sawtimber size class will be heaviest on the controls; in the 8- and 9-inch dbh classes the checks had 140 trees per acre and the thinned plots had 15 to 51 trees per acre (table 7).

Table 6. — *Sawtimber production of loblolly pine, including thinnings, at different assumed harvest ages, by treatment*

Thinning treatment	Assumed harvest age — years			
	30	35	40	45
	— — *Bd. ft. (Int. ¼-inch rule)* — —			
B. A. 70	9,944	14,464	17,777	21,807
B. A. 85	10,494	16,176	19,199	23,364
B. A. 100	10,578	15,570	20,771	24,577
Unthinned	9,750	14,445	18,427	22,024

DISCUSSION

It is well established that cubic volume growth is higher on unthinned stands than on thinned stands until age 35 to 40, when mortality from suppression begins to set in. Saw-

Table 7. — *Slash pine trees per acre removed in three thinnings and standing at age 32 years, by 1-inch dbh classes and thinning treatments*

Thinning treatment; no. of stems cut and standing	Diameter class — inches												
	4	5	6	7	8	9	10	11	12	13	14	15+	Total
	— — —

timber volumes are comparable on thinned and unthinned stands until a much later age, when suppression begins to kill trees of sawlog size. Thinning, however, does shorten the rotation to obtain trees of a specified size.

In the loblolly plantation, sawtimber volumes on the checks were comparable to those on the heavily thinned plots but somewhat lower than those on light- and medium-thinned plots at all rotation ages. This difference reflected, primarily, a lag in ingrowth into the 10-inch dbh class on the checks, as evidenced by the relatively large number of trees just below sawtimber size on the checks. Given a few more years for ingrowth into the sawtimber sizes to be completed, volumes on the checks would probably compare favorably with those on thinned plots.

However, to obtain about the same total volume of sawtimber from thinned plots as from checks, many more stems had to be cut. By 45 years, total trees logged was about 50 to 100 percent more on thinned than on check plots. Differences were largely in the smaller size classes.

Initial spacing can affect results substantially, as demonstrated by the slash data. Here the planting spacing was 6- by 7-feet and 200 to 300 small trees per acre had to be cut in thinnings to obtain a few more large trees than on the check plots.

Handling such a large number of small trees is costly. But the overall effect on logging costs of having a few more large trees at the expense of many small ones can only be determined by each landowner. Companies doing their own logging are apt to be more cognizant of the high costs of removing small trees than those depending on contract logging.

There are other factors the landowner must consider in deciding whether or not to thin. If he chooses not to thin, the cost of marking and supervising thinning operations is saved, there is no pressure to cut heavier than is silviculturally desirable to make logging operations economically attractive, and disease and insect problems resulting from logging are eliminated. Some major disadvantages include deferred returns, greater susceptibility of dense stands to bark beetles, and retention of high-risk and inferior trees.

Selecting a management system is complex, and alternatives must be judged in context with landowner goals. Site quality may also influence decisions. Trends given here are applicable to good and choice sites, but they may not be valid for poorer sites where crown differentiation is often slow and stagnation may occur. For these reasons, there is no universal choice for all properties.

Mann, W. F., and D. P. Feduccia.

1976. Tree sizes harvested in different thinnings—another look. South. For. Exp. Stn., New Orleans, La. 6 p. (USDA For. Serv. Res. Pap. SO-131)

In loblolly planted at 10 by 10 feet, light- and medium-thinned plots had slightly more sawtimber-sized trees and board-foot volume than unthinned checks and heavily thinned plots at all ages. Average diameters of all trees were largest on checks, followed by light-thinned plots. Trends were similar for 32-year-old slash pine planted at 6 by 7 feet.

ADDITIONAL KEYWORDS: Diameter distributions, average diameter, *Pinus taeda, Pinus elliottii.*

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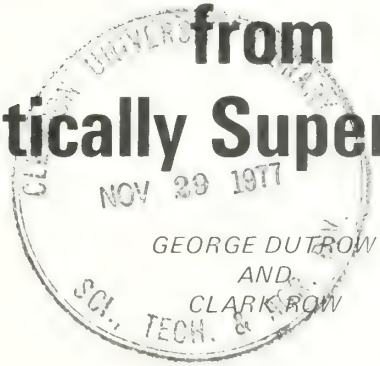
Measuring Financial Gains from Genetically Superior Trees



GEORGE DUTROW
AND
CLARK ROW

Southern Forest Experiment Station

Dutrow, George, and Clark Row.
1976. Measuring financial gains from genetically superior trees. South. For. Exp. Stn., New Orleans, La. p. (USDA For. Serv. Res. Pap. SO-132).

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Additional keywords: Computer simulation, tree improvement, economic gains, *Pinus taeda*.

Measuring Financial Gains from Genetically Superior Trees

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SUMMARY

Planting genetically superior loblolly pines will probably yield high profits. Forest economists have made computer simulations that predict financial gains expected from a tree improvement program under actual field conditions. Equations were derived from data on height, diameter, volume, and survival of unimproved loblolly plantations, and were then modified to show gains made by 8-year-old trees in actual tree improvement programs. Growth of genetically improved plantations was then analyzed, and financial gains were calculated for a 24-year rotation for each of 472 genetic crosses. Before economists can predict specific dollar returns, they must find out the growth patterns of superior trees during an entire rotation. The model also needs to be refined to show impact of fusiform rust on growth and yield, to indicate form classes of genetically improved trees, and to determine if large, small, or all trees make the gains.

Additional keywords: Computer simulation, tree improvement, economic gains, *Pinus taeda*.

Dutrow, formerly Forest Economist with the Southern Forest Experiment Station, New Orleans, Louisiana, is now with the Southeastern Forest Experiment Station, Durham, North Carolina. Row is a Forest Economist with the Forest Service, Washington, D.C.

Rising demands for wood products have stimulated land managers to initiate tree-improvement programs to increase per-acre yields. The success of such programs depends on how much can be spent on improved planting stock, what benefits can be expected at harvest, and how greatly revenues can be increased by the genetically superior trees. This paper describes a method for analyzing the economics of tree improvement.

Most economic analyses of tree improvement programs compute per-acre gains by extrapolating data from improved trees grown under special conditions rather than in the field (Lundgren and King 1966, Davis 1967, Porterfield 1974, Swofford and Smith 1972). The present analysis projects economic gains for improved loblolly pine plantations after actual field conditions were simulated. Our method was to derive growth equations incorporating data for unimproved loblolly plantations. After modifying these data to show gains obtained in an actual tree improvement program, we analyzed the growth of genetically improved plantations. We then estimated economic gains reflecting the influence of actual stand conditions on stumpage prices and harvesting costs, which have been shown to affect returns significantly (Row 1973).

DATA

A computer program (Row 1974) was developed to transform mathematical functions (Bailey and Clutter 1970, Lenhart and Clutter 1971) describing the growth of unimproved loblolly pine plantations. The data reflected 8-year gains in growth and volume of genetically improved planting stock with a geographic range extending from Virginia to Georgia and from the Coastal Plain to the Piedmont.[1] Although fusiform rust infection levels varied widely throughout the area, our simulation assumes that infection and mortality were randomly distributed throughout the data set. Our analysis combines data for the entire area though it would be possible to analyze each geographic province separately.

Average growth values were available for a total of 472 genetic crosses. There were 27 sets of tests for each genetic cross; each set included a check test and from 7 to 33 crosses averaging 27 surviving trees per cross. The descriptors measured were increases in height, diameter, volume, and survival.

1 Gains were derived from data obtained from the North Carolina State Cooperative Tree Improvement Program.

Height.--Height-adjustment ratios were derived by dividing the average height of each genetic cross by the average height of the unimproved check trees. The height-adjustment ratio was then used to simulate heights of genetically improved trees at age 24. Heights of unimproved stands of loblolly pine were calculated by the following expression (Lenhart and Clutter 1971):

$$\text{Log}_{10}(H) = 1.5469 - 11.406/T + 10^{(2.9110/T)}[\,.76481\ \text{Log}_{10}(SI) - .83419\,],$$

where H is height of dominant trees, T is the plantation age, and SI is the site index. The estimated height of unimproved trees was then multiplied by the height-adjustment ratio to provide an estimate of the height increment of genetically improved trees. The same formula was then reapplied to calculate an apparent increase in site index, a value considered a measure of gains achievable through genetic control.

In the simulation, 50 percent of the genetic trials showed height gains in excess of 2.6 percent (Figure 1); average gains were 3.5 percent. Growth rate increases of more than 10 percent were recorded for almost 17 percent of the genetic trials.

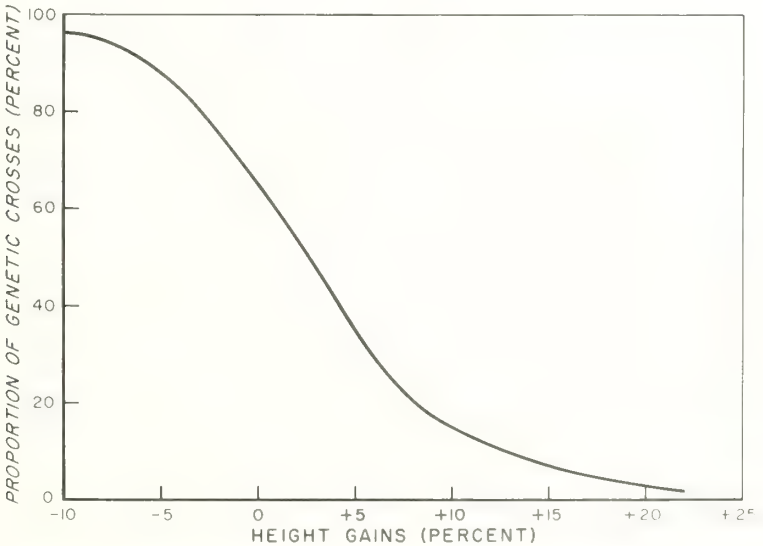

Figure 1. Proportion of genetic crosses exceeding percentage gains in height

Diameter.--Diameter-adjustment ratios were derived by dividing the average diameter of each genetic cross by the average diameter of unimproved trees. Tree gains were converted to stand gains by applying the diameter-adjustment ratios to anticipated minimum and maximum diameters; the relative frequency of basal area occurring for the enlarged diameters was also calculated. The techniques applied were developed for unimproved loblolly pine (Lenhart and Clutter 1971). With a beta distribution, the relative frequency of basal area occurring on trees of diameter D_i (expected basal area per interval) is:

$$f(D_i) = \frac{\Gamma(\alpha+\beta+2)}{(D_{max}-D_{min})\,\Gamma(\alpha+1)\,\Gamma(\beta+1)} \left(\frac{D_i-D_{min}}{D_{max}-D_{min}}\right)^{\alpha} \left(\frac{D_i-D_{min}}{D_{max}-D_{min}}\right)^{\beta}$$

where

$f(D_i)$ = relative frequency of basal area occurring on stems with diameter D_i.

D_{min} = minimum diameter of trees in the stand.

D_{max} = maximum diameter of trees in the stand.

In the expression, alpha, beta, and gamma are distribution parameters defining the shape of the frequency curve and its values. The distribution parameters are functions of age and were not changed by calculating expected values of increased diameters. Our computer program divided the range of diameters into 20 equal intervals (smallest to largest) and converted the results into the expected number of genetically superior trees in each interval. The basal area and average diameter of a genetically improved stand was then computed from the final tabulation of diameters by intervals.

Our simulation showed notable gains in diameter (Figure 2). Fifty-four percent of the genetic crosses showed diameter growth that equaled or surpassed the unimproved trees. Average increases were about 2 percent; median gain was about 1.0 percent. Although average and median values for height increases of the genetic crosses exceeded those for diameter increases, a larger proportion of the crosses showed high gains in diameter. Nineteen percent or more of the genetic trials exceeded a 10 percent increase in diameter as compared to 17 percent for height.

Volume.--Since gains in merchantable volume harvested are not directly proportional to gains in juvenile volumes, we did not compute volume-gain ratios. Instead, we computed volume

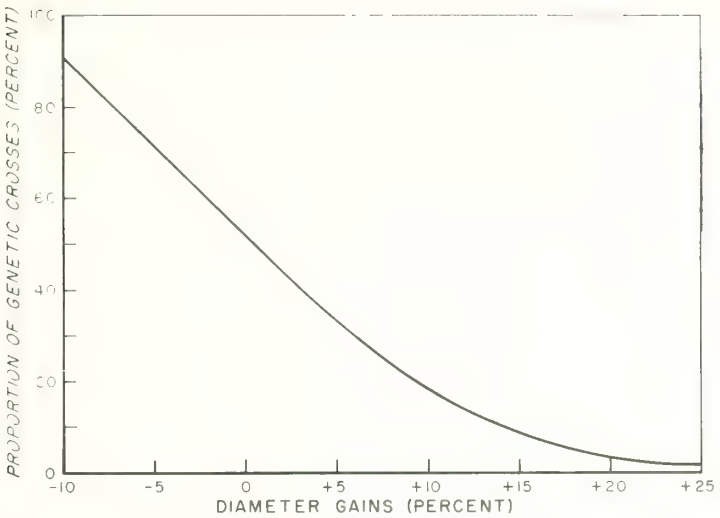

Figure 2.– Proportion of genetic crosses exceeding percentage gains in diameter.

by estimating diameters and heights at age 24 and inserting these values into volume equations developed by Goebel and Warner (1962).

Simulated harvest volumes of genetically improved trees showed substantial gains over volumes of unimproved trees (Figure 3). Average increase in volume per acre was about 12 percent; median gain was 7 percent. On large tracts of

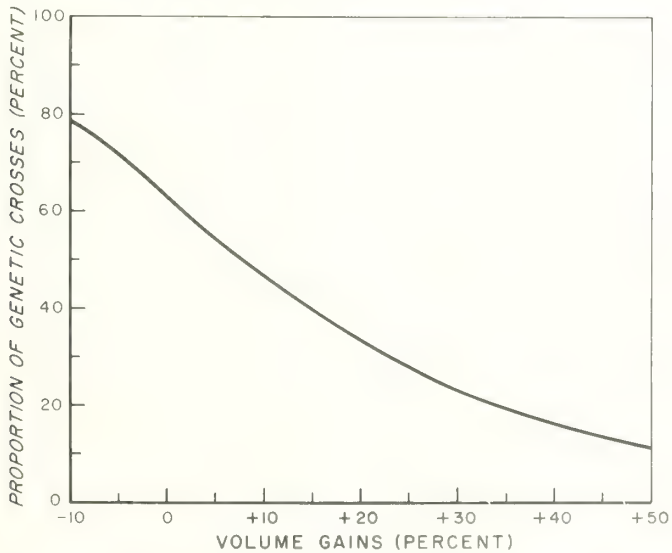

Figure 3.– Proportion of genetic crosses exceeding percentage gains in volume.

managed timber, 63 percent of the acres consisting of improved trees would exhibit growth rates higher than would acreage composed of unimproved trees. Furthermore, 20 percent of the acreage of improved trees would display volume gains of more than 30 percent.

Survival.—Survival gains were incorporated into the analysis as probability factors. The gains were compared to values obtained for unimproved plantations (Lenhart and Clutter 1971). When the distribution did not prove normal, and when variations in survival appeared much higher than those obtained for height and diameter, differences in survival between improved and unimproved trees were accounted for by transforming the survival rates into probit form. Probits computed for survival of improved stock were then compared with those of unimproved trees. The Lenhart and Clutter (1971) expression of loblolly plantation survival distribution was:

$$\text{Probit (S)} = 9.3745 - .67637\ [\text{Log}_{10}(T)]\ - .96269\ [\text{Log}_{10}(N_o)]\ ,$$

where S is the surviving proportion, T is the plantation age, and N_o is the original number of seedlings planted per acre. The probits found in the Lenhart-Clutter study were normally distributed; standard error was .448. The range in probability (P) was from 0.0 to 1.0 (poorest to best); average survival probability was 0.5. Genetic improvement in survival was measured as the proportional increase in average P of the genetic crosses to P of controls.

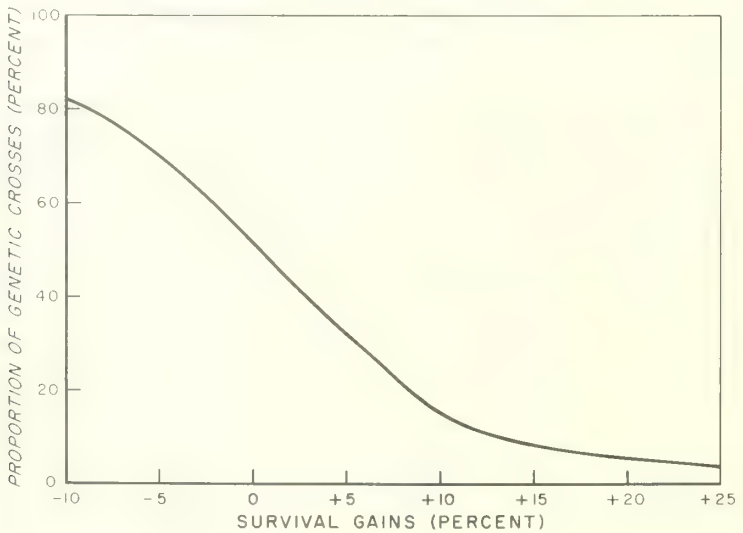

Figure 4.– Proportion of genetic crosses exceeding percentage gains in survival.

Although the genetic tests did not include loblolly seed sources selected for increased survival, our data suggested that survival of progeny at age 8 exceeded that of controls (Figure 4). An average survival rate of 91.7 percent was recorded for genetically improved trees; the rate for checks was 86.3 percent. About 52 percent of the genetic crosses showed a higher survival rate than unimproved trees. Slightly more than 15 percent of the genetic selections demonstrated exceptional survival rates—more than 10 percent greater than survival of unimproved stock.

Financial Results of Planting Genetically Improved Trees

Management regime.--In the simulation, financial gains from genetically improved stock were calculated for a 24-year rotation for each of the 472 crosses. Management assumptions were: that the stands would be established on old-field sites or prepared cutover timber stands; that there would be 500 seedlings planted per acre; that site index would be 65 feet at age 25; and that the plantations would be harvested for pulpwood at age 24 without prior thinning.

Prices and costs.--The value of timber clearcut at age 24 was based on an equation developed for determining the stumpage price of National Forest pulpwood and sawtimber sales (Row 1973). The cubic foot price is derived from the following expression:

$$P = -5.35 + 2.253\ (D) - 0.024\ (D)^2 + 0.452\ (v),$$

where P is the price in cents per unit, D is average diameter, and v is the merchantable volume per acre. The discount rate was set at 7 percent, equivalent to a discount rate of 10 percent or more if the inflationary tendency of timber prices is introduced into the compound interest calculations. Plantation costs were disregarded, since the cost of establishing improved stock would be the same as that for unimproved with the exception of a premium for superior seedlings. The choice of whether or not to invest in a tree improvement program would then be based on returns from improved trees.

Returns.--Present net worth and annual equivalent income were the criteria chosen to evaluate financial implications. Only financial gains attributable to the use of genetically improved stock were considered. These gains were computed by dividing returns anticipated with improved trees by those expected from unimproved planting stock.

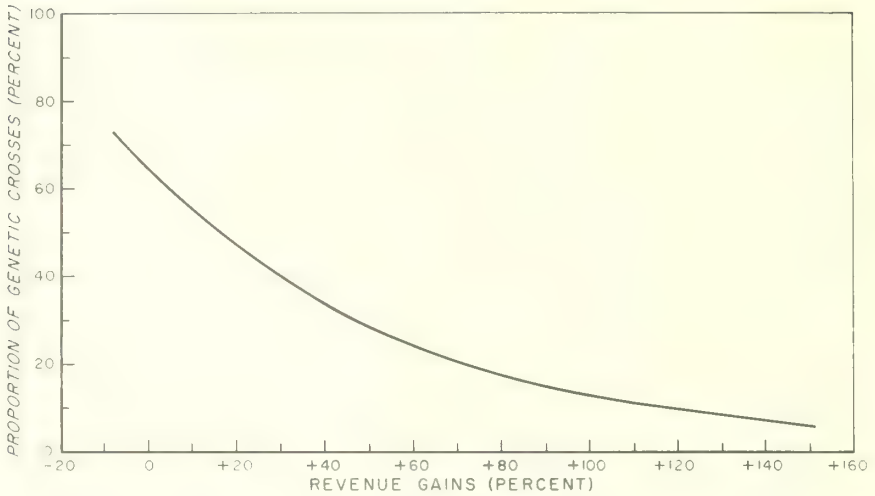

Figure 5.– Proportion of genetic crosses exceeding percentage gains in revenue.

About 6 percent of the genetic crosses showed financial gains of up to 150 percent (Figure 5). Average increase in present net worth was 29 percent, and median value was 16 percent. Very few of the genetic crosses indicated returns poorer than those of the controls.

The estimates can be transformed directly from percentage to dollar gains for private plantation managers. Industrial landowners can expect nearly a 30 percent increase in present net worth. For example, if a forest manager estimates a net worth of his loblolly plantations at $100 per acre, he can increase that estimate by about 30 percent or $30 if he changes to genetically superior stock. Or, stated differently, he can afford to pay up to $30 more per acre for genetically improved seedlings.

For large timber producing regions or ownerships with substantial acreages, gains from tree improvement justify large expenditures in nurseries, orchards, and research to assure even higher productivity. For example, in the three-state area of South Carolina, Georgia, and Florida, loblolly pine plantations occupy about 1,100,000 acres (Powers et al. 1975). If, through conversion to genetically improved trees, financial productivity per acre could be increased by 30 percent, extremely large investments in tree improvement efforts, with associated economics of scale, would be justified. Since the forest land base is shrinking, publicly subsidized tree improvement efforts would enhance wood supplies on acreage retained for commercial production.

Previous economic analyses, particularly Porterfield's (1974), have shown that tree improvement investments are not only advisable but that returns would increase directly with the level of expenditure and effort. Our results indicate probable financial gains from genetic crosses that have not been rogued. In commercial operations, in which poor trees would be rogued, expected financial gains would be even higher than those shown here. These expectations would emanate from selecting from the upper segments of the initial distribution. An analysis of increased selection efforts, intensive roguing, and the resulting economies are contained in Porterfield's (1974) study. Since the present analytical technique is suitable for an entire tree-improvement program as well as for the portions remaining after roguing, this method can be used to predict gains after roguing and selection.

Improving the Method

Improvements in methodology for conducting economic analyses are limited by a lack of data for improved juvenile trees and by the lack of mathematical models of stand development. Future analyses of tree improvement would be improved by the following:

1. Improved knowledge of whether or not growth gains or specific gravity changes evident in the early years of the plantation will continue at the same or at increased or decreased rates throughout the rotation.
2. Volume equations reflecting improved form class of genetically improved trees and therefore requiring upper-stem diameter measurements.
3. Statistics about individual tree diameters and heights to determine if genetic gains are obtained primarily with large trees, small trees, or all trees proportionally.
4. Development of a dynamic model of fusiform rust infection to measure the impact of rust on both the entire stand and on individual tree diameters, heights, and volumes.

CONCLUSIONS

The results suggested here are subject to revision. Subsequent analyses will include additional data on growth patterns throughout the rotation. Ultimately, such information will

reveal full-rotation performance when these trees compete with other superior trees in a plantation environment. Only after such comparisons will valid growth or wood fiber production equations be available. At the same time, economic research must provide accurate information about costs and future revenue possibilities. Achieving these objectives will enable each owner or planner to set goals suitable to his own situation and thus derive local estimates of financial gain. Investments in genetically superior planting stock will probably be highly profitable; yet, efforts to prescribe the investment levels necessary to achieve specific dollar returns remain clouded by uncertainty.

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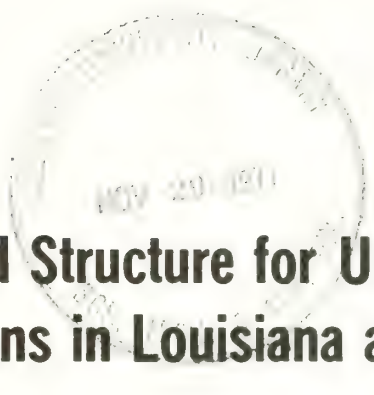

Yield Tables and Stand Structure for Unthinned Longleaf Pine Plantations in Louisiana and Texas

RICHARD E. LOHREY
AND
ROBERT L. BAILEY

Southern Forest Experiment Station

SUMMARY

A system of equations is developed to forecast number of trees per acre, basal area, and cubic foot yields in eight volume categories by 1-inch diameter classes for several combinations of site index, age from planting, and either number of trees planted, number of trees surviving, or basal area at a given age.

Additional keywords: Pinus palustris, volume predictions, unthinned plantation yields, volume yields of longleaf pine.

Conversion factors: English to metric

Multiply		By		To Obtain
Inches	x	2.540	=	centimeters
Feet	x	.3048	=	meters
Cubic feet	x	..02832	=	cubic meters
Number per acre	x	2.471044	=	number per hectare

All English units of measure in this report can be converted to metric units by multiplying by the appropriate conversion factor listed above.

ERRATA SHEET

Yield Tables and Stand Structure for Unthinned Longleaf Pine Plantations in Louisiana and Texas

Research Paper SO-133

by

Richard E. Lohrey and Robert L. Bailey

Page 10, figures 2 and 3 are reversed and should be replaced with the attached page.

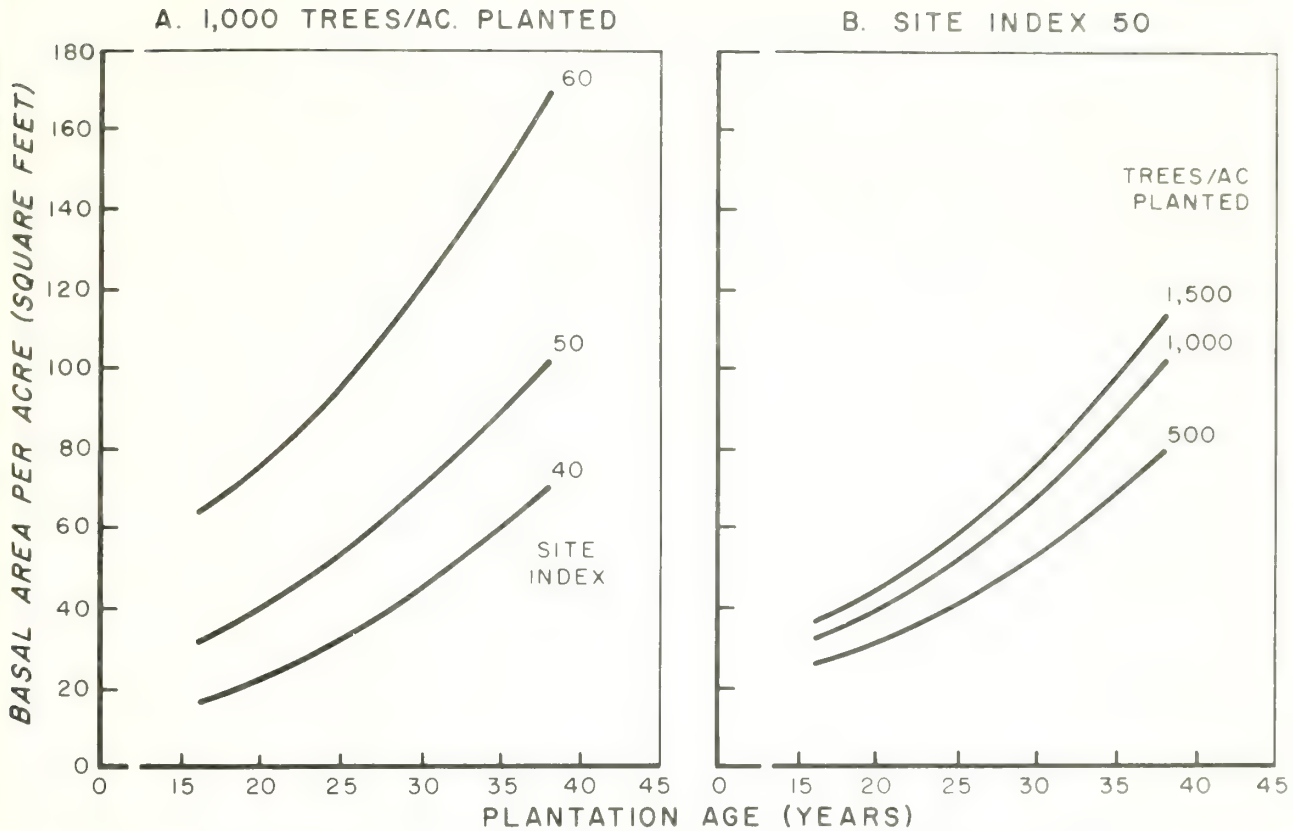

Figure 2.—Total basal area per acre related to age for different sites (A) and planting densities (B)

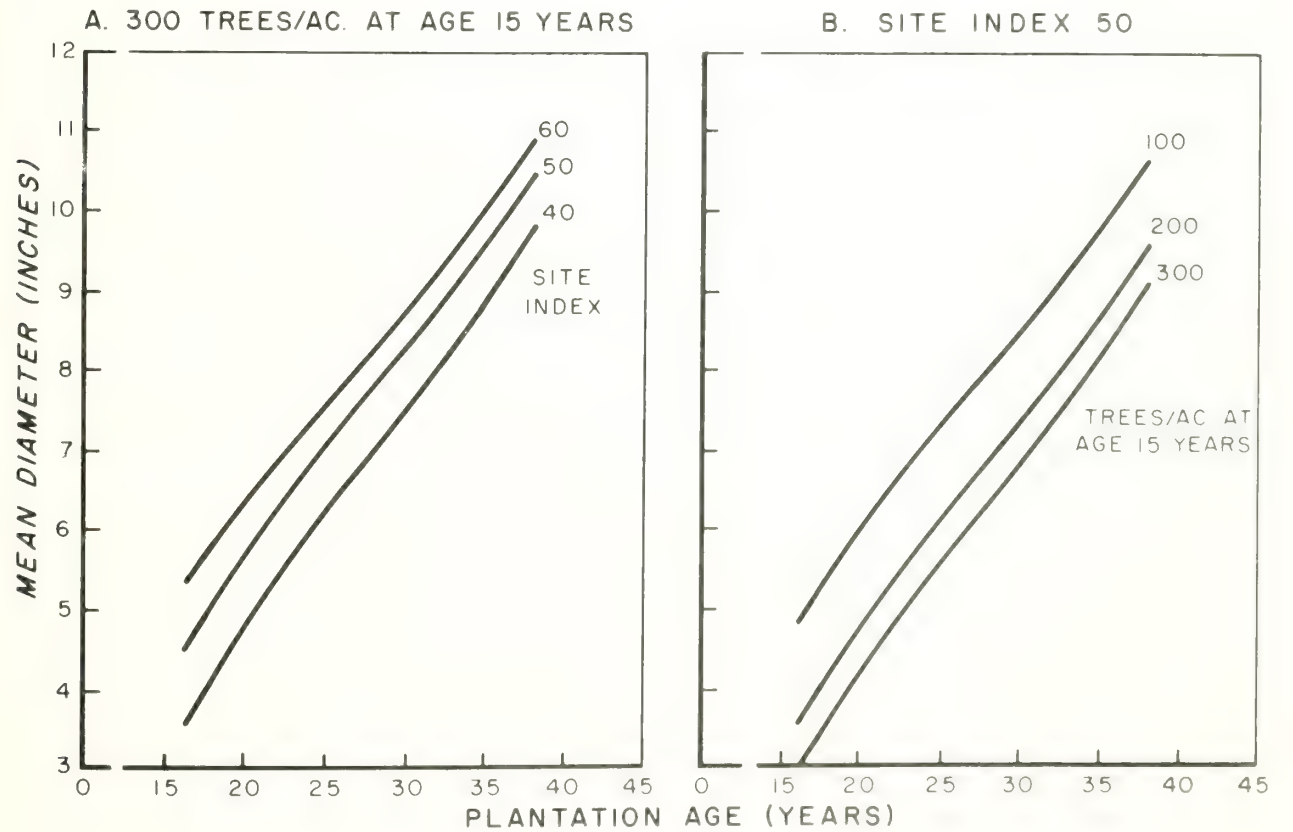

Figure 3.—Quadratic mean diameter related to age for different sites (A) and stand densities at age 15 years (B).

Yield Tables and Stand Structure for Unthinned Longleaf Pine Plantations in Louisiana and Texas

RICHARD E. LOHREY
AND
ROBERT L. BAILEY

Longleaf pine (Pinus palustris Mill.) forests once occupied 60 million acres from Virginia to Texas, but their area was greatly decreased when the original stands were harvested. In Louisiana and Texas there is renewed interest in the species. Landowners need to know what yields can be expected from longleaf pine plantations before large expenditures for planting can be considered.

This paper presents equations that make it possible to forecast:

a. Number of trees per acre surviving at age 16 years from number of trees planted and site index.

b. Number of trees per acre surviving at a future age (A_2) from the number at a first inventory (A_1).

c. Diameter distributions from number of living trees per acre, age, and height of the dominant stand.

d. Basal area per acre from number of living trees per acre, age, and height of dominant stand.

e. Total volume yields i.b. or o.b. in all trees and merchantable volume yields i.b. or o.b. in trees > 3.5 inches d.b.h. to any top diameter o.b. of 4 inches or less from site index, age, and one of the following: number of trees planted, number of trees surviving, or basal area at a given age.

f. Periodic volume growth, in the same units as yields, for a given age interval (A_1 to A_2), site index, and either surviving stems or basal area per acre at age A_1.

Readers interested only in Stand and Stock Tables and a brief discussion of growth trends should turn directly to page 9.

The Stand and Stock Tables show expected cubic-foot yields, basal area, and number of stems by 1-inch diameter classes for several combinations of:

Density at age 15 years—100 to 700 trees per acre in increments of 100
Site index (base age 25)—40 to 70 feet in intervals of 10
Age from planting—15 to 40 years in intervals of 5.

Similar tables for various combinations of site index, age, and basal area, or for combinations of site index, age, and number of trees per acre planted, can be derived from the equations. Readers with computer facilities can acquire copies of the programs, which are written in FORTRAN, from the Southern Forest Experiment Station, Biometrics Branch, T-10210 U. S. Postal Service Building, 701 Loyola Avenue, New Orleans, Louisiana 70113.

PLANTATION MEASUREMENTS

Diameter, height, and age data were obtained from 260 unthinned plots in longleaf pine plantations in central Louisiana and east Texas, and from 176 remeasurements on these plots. All stands were at least 16 years old from planting, were on unprepared cutover forest sites, showed no evidence of severe insect or disease damage, and most had been burned by prescription. The extent to which hardwood understories were present depended upon the

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frequency and effectiveness of prescribed fires.

All plots were rectangular and 0.10 to 0.25 acre in area. The diameter at breast height of each tree on the plot was measured to the nearest 0.1 inch. Total heights of 8 to 15 dominants and codominants per plot were measured to the nearest 1.0 foot. Stand age, determined from planting records, was used with mean total height of dominants and codominants to determine site index (at base age 25 years) for each plot (Farrar 1973).

The distribution of observations by age, site index, and surviving density is shown in table 1. Plantation ages ranged from 16 to 38 years, site indices from 29 to 73 feet, planting densities from 250 to 2,500 trees per acre, and surviving densities from 30 to 1,547 trees per acre. Only 26 plots had more than 750 and 6 plots more than 1,000 surviving pines per acre. Longleaf usually has lower stocking levels than other southern pines, and most plots had densities that were from low to medium for other species.

Heights to succeeding 2-inch diameter taper steps outside bark were measured to the nearest foot on sample trees proportioned among diameter classes, and volumes of these trees were determined by height accumulation (Grosenbaugh 1954). Plot volumes, basal areas, and diameter distributions were computed from diameter data and sample tree volumes (Lohrey and Dell 1969). Height accumulation data from 1,245 trees randomly selected from 73 plots were used to develop relationships between tree basal area and volume.

MODEL DEVELOPMENT AND EVALUATION

Survival

Two procedures were derived for estimating the number of surviving trees per acre. The first predicts living stems per acre at age 16, and the second predicts number of survivors 1 or more years after an inventory made at age 16 or later.

The number of trees planted and site index were screened to estimate transformed survival proportion of the number planted on 166 plots measured at age 16. The arcsine - square root transformation [$Y = \sin^{-1}(\sqrt{x})$, where x = proportion of stems surviving] was used to stabilize the variance and better satisfy normality of error assumptions. The equation for the number of survivors at age 16 is

$$\hat{N}_{16} = N_0 \sin^2 [0.862809 + 0.449040 S^3 10^{-5} - 0.002801 S \text{ Ln } (N_0)] \quad (1)$$

where

N_0 = trees per acre planted,
$\hat{N}_{16}$ = predicted trees per acre at age 16 years,
S = site index (25),
Ln = natural (base e) logarithm, and angles are measured in radians.

The equation explained 65.9 percent of the variation in surviving stems per acre at age 16 years.

Data used to estimate survival came from both prescribe burned and unburned stands. Burning at early ages doubled survival at age 16 in one study. In estimating yields, therefore, it is better to use number of survivors or basal area per acre rather than the number of trees planted.

Data from 176 remeasurements on plots that were 16 to 30 years old when first measured were screened to fit an equation that estimates stand density at the second inventory as a proportion of that at the first one. The proportion was related to age and stand density at the first inventory. The arcsine - square root transformation was used again. The equation for surviving trees after an initial inventory is:

$$\hat{N}_2 = N_1 \{\sin^2 [\pi/2 + (1 - A_1/A_2)(-2.827365 - 0.032141\sqrt{N_1} + 0.221332A_1 - 0.004125 (A_1)^2)]\}, \quad (2)$$

where

A_1 = stand age in years at the first inventory,
A_2 = stand age in years at the second inventory,
N_1 = stems per acre at age A_1,
$\hat{N}_2$ = predicted stems per acre at age A_2, and angular measurements are in radians.

Table 1.—Distribution of observations in unthinned longleaf pine plantations by age, site index and surviving density

Age	Site index (age 25)					Total
	26-35	36-45	46-55	56-65	66-75	
Years	- - - - - - - - - - *Number of points* - - - - - - - -					
15-19	5	53	62	38	17	175
20-24	...	22	58	33	1	114
25-29	...	14	40	13	...	67
30-34	...	9	31	3	...	43
35-39	...	5	30	2	...	37
Total	5	103	221	89	18	436

Age	Surviving density (trees per acre)						Total
	0-150	151-250	251-350	351-450	451-550	551+	
Years	- - - - - - - - - - *Number of points* - - - - - - - -						
15-19	58	32	27	16	9	33	175
20-24	17	9	15	20	19	34	114
25-29	17	7	11	5	7	20	67
30-34	16	6	7	7	1	6	43
35-39	24	10	2	1	...	...	37
Total	132	64	62	49	36	93	436

Site index (age 25)	Surviving density (trees per acre)						Total
	0-150	151-250	251-350	351-450	451-550	551+	
Feet	- - - - - - - - - - *Number of points* - - - - - - - - -						
26-35	4	1	...	...	...	...	5
36-45	81	9	6	3	2	2	103
46-55	45	42	48	28	19	39	221
56-65	2	12	8	18	15	34	89
66-75	...	...	...	...	...	18	18
Total	132	64	62	49	36	93	436

A logical constraint within the equation forces $\hat{N}_2 = N_1$ if $A_2 = A_1$. Equation (2) explains 99.7 percent of the variation about mean N_2 for the 176 remeasurements.

By using equation (1), (2), or both (1) and (2), the number of trees per acre can be determined for any planting density, site index, and age ≥ 16 years. To construct yield tables, survival at age 15 was obtained by extrapolation.

Diameter Distributions

The Weibull probability density function was fitted to the 1-inch-class diameter distributions (Bailey and Dell 1973) by maximum-likelihood estimation (Bailey 1974). Only 1 fitted distribution out of 436 was significantly different from the observed when tested by the Kolmogorov-Smirnov test (Massey 1951) at the 0.10 probability level and none at the 0.05 level. Maximum difference between quadratic means of fitted and observed distributions was -0.643 inch.

The three Weibull parameter estimates (a, b, and c) can be transformed into distribution percentiles by applying equations of the form:

$$\hat{Y}_p = a + b\,(-\text{Ln}\,(1-p))^{1/c} \qquad (3)$$

where $\hat{Y}_p$ is the estimated distribution percentile, p is the probability of a value less than $\hat{Y}_p$, and Ln (1-p) is the natural (base e) logarithm of the quantity (1-p).

Conversely, Weibull parameters for the two-parameter formulation (b and c only, a = 0) can be determined from any two percentiles. An approach was developed along these lines which uses the 24th and 93rd percentiles (Bailey 1973). Various linear and curvilinear functions of stand age, height of dominants and codominants, and number of surviving trees were screened in all possible regressions with the REX program (Grosenbaugh 1967) to find three-variable equations that gave best predictions of the two percentiles. The equations are:

$$\hat{Y}.24 = 15.2275 - 1.2961\,\text{Ln}(N_t) + 0.3362\,A^3\,10^{-4} - 0.1652\,H^{-1}10^3, \qquad (4)$$

$$R^2 = 0.74;$$

$$\hat{Y}.93 = 17.8711 - 1.1191\,\text{Ln}(N_t) + 0.9717\,A^3\,10^{-4} - 0.1651\,H^{-1}10^3, \qquad (5)$$

$$R^2 = 0.89;$$

where

$\hat{Y}.24$ and $\hat{Y}.93$ are predicted values of the percentiles computed from maximum-likelihood estimates of a, b, and c,

A = stand age,

H = height of dominant stand at age A, and

N_t = number of surviving trees per acre at age A.

Equations (4) and (5) and the expressions:

$$\hat{c} = 2.271082/\text{Ln}(Y.93/Y.24) \text{ and}$$

$$\hat{b} = Y.24/(0.274436)^{1/\hat{c}} \text{ (Bailey 1973)} \qquad (6)$$

were used to predict b and c of the two-parameter Weibull. Eighty-three percent of the estimated diameter distributions were not significantly different from the observed ones at the 0.05 level and 89 percent of the deviations between observed and predicted mean diameters were within $\pm$ 1.0 inch.

Because predicted values with equations (4) and (5) are sometimes negative--especially for early ages, low site indices, or high densities--lower bounds of 2.5 and 1.5 were placed on predictions of b and c to keep predicted volumes from being negative.

Basal Area

Basal area per acre can be determined from the number of trees per acre and the corresponding diameter distribution parameters. The number of trees can be determined by equation (1), (2) or both (1) and (2) and Weibull parameters b and c by equations (4), (5), and (6). Then basal area per acre can be estimated by the equation:

$$\hat{B} = 0.005454\,N_t\,\hat{b}^2\,\Gamma(1 + 2/\hat{c}), \qquad (7)$$

where

$\hat{B}$ = basal area per acre,

$\hat{b}$ & $\hat{c}$ = predicted Weibull parameters, and
$\Gamma(x)$ = gamma function of x
$= \int_0^\infty e^{-t} t^{x-1} dt.$

This method explained 79 percent of the variation in basal area for the 176 remeasurements and 74 percent of the variation in basal area for the 166 plots measured at age 16.

When specific levels of basal area are desired, equations (4), (5), (6), and (7) are iteratively solved for the corresponding N_t.

Volume Yields

Stand basal areas from the 436 yield observations were used to develop volume yield prediction equations. A yield model reported by Clutter (1963) was fitted:

$$E[Y_i] = b_0 + b_1 S + b_2 (A_i)^{-1} + b_3 Ln(B_i), \quad (8)$$

where
Y_i = natural logarithm of stand volume in cubic feet at age A_i in years,
S = site index in feet,
$Ln(B_i)$ = natural logarithm of stand basal area in square feet at age A_i, and E indicates expected value.

The mathematical form of the model is desirable because it implies relationships that agree with certain concepts of even-aged stand development. Using Ln(V) in place of V as the dependent variable is compatible with statistical assumptions (linearity, normality, additivity, and homogeneity of variance), and is a convenient way to express mathematically the interaction of the independent variables (Clutter 1963).

From the basic model, equations that predict the following are developed:

Symbol	Description
V_o	Volume in cubic feet per acre of total bole outside bark including all trees with d.b.h. > 0.5 inch.
V_i	Volume in cubic feet per acre of total bole inside bark including all trees with d.b.h. > 0.5 inch.
V_{4o}	Volume in cubic feet per acre outside bark to a 4-inch top o.b. including all trees with d.b.h. > 3.5 inches.
V_{4i}	Volume in cubic feet per acre inside bark to a 4-inch top o.b. including all trees with d.b.h. > 3.5 inches.

Two logical requirements were placed on predicted yields:

$$\hat{V}_o \geq \hat{V}_i \geq \hat{V}_{4i}, \text{ and}$$
$$V_o \geq V_{4o} \geq V_{4i} \quad (9)$$

When merchantable yield data were initially fitted to the model these requirements were violated, so differences between total and merchantable yields were predicted as proportions of total yield. The arcsine-square root transformation was used to normalize errors. The equations are:

$$Ln(\hat{V}_o) = 3.291079 + 0.014579S - 16.513309/A + 0.976898Ln(B), \quad (10)$$

$$Ln(\hat{V}_i) = 3.178362 + 0.015977S - 22.532962/A + 0.967365Ln(B), \quad (11)$$

$$Sin^{-1}\{(1-\hat{V}_{4o}/V_o)^{1/2}\} = 1.147626 - 0.035842A + 0.610749A^3\ 10^{-5} + 0.001449B - 0.983740S^3\ 10^{-6}, \quad (12)$$

$$Sin^{-1}\{(1-\hat{V}_{4i}/V_i)^{1/2}\} = 1.197269 - 0.034380A + 0.554603A^3\ 10^{-5} + 0.001506B - 0.821871S^2\ 10^{-4}, \quad (13)$$

In constructing the Stand and Stock Tables presented in the appendix, these four equations were solved for total and merchantable volume yields inside and outside bark. The tables were derived from observed stems per acre, and the equations explained 92 to 94 percent of the variation in volume (Table 2, section II). Average errors ranged from 0.5 to 4.7 percent.

When stand yields were predicted from observed basal area each equation explained 98 percent of the variation about mean volume (Table 2, section III). The equations explained 73 to 80 percent of the variation in yields when estimated basal area (determined from planting density) was substituted for observed basal area

Table 2.—Evaluation of predicted survival, basal area, and volume yields per acre

Variable[1]	R^2	Average errors	Predicted relative to observed were within: 10 percent	25 percent	20 units	50 units	100 units	500 units	Predicted minus observed: Negative	Positiv
	- Percent -		- - - - - - - - - - - - Percent of cases - - - - - - - - - - - - - - - -							
		I Survival, basal area, and volume yields predicted from planting density[2]								
S.P.A.	43	-10.6	13	36	20	35	55	98	69	31
B.A.	67	-10.2	15	49	62	93	100	100	73	27
V_o	73	- 8.8	16	48	6	15	27	62	73	27
V_i	74	- 8.8	17	48	8	22	35	72	72	28
V_{4o}	78	- 3.4	21	50	9	19	32	68	71	29
V_{4i}	80	- 6.1	20	50	14	27	43	79	70	30
		II Basal area and volume yields predicted from observed stems per acre[2]								
B.A.	88	- .3	40	84	84	99	100	100	57	43
V_o	92	.5	38	78	9	22	38	86	57	43
V_i	93	.5	39	80	14	31	50	92	56	44
V_{4o}	93	4.7	38	78	10	25	44	88	55	45
V_{4i}	94	2.2	38	79	14	34	54	94	54	46
		III Survival and volume yields predicted from observed basal area per acre[2]								
S.P.A.	60	10.9	27	59	27	49	72	98	43	57
V_o	98	.7	65	95	18	36	57	96	53	47
V_i	98	.7	63	95	25	45	67	98	49	51
V_{4o}	98	4.3	60	90	19	37	57	97	50	50
V_{4i}	98	2.2	58	90	25	48	69	97	48	52
		IV Future survival, basal area, and volume yields predicted from current basal area[3]								
S.P.A.	94	- 5.6	67	88	61	84	93	100	72	28
B.A.	93	6.4	57	87	94	100	100	100	34	66
V_o	94	6.4	43	86	9	19	31	90	39	61
V_i	95	6.3	44	87	12	26	44	97	40	60
V_{4o}	94	8.9	38	82	8	19	30	93	32	68
V_{4i}	96	8.9	40	80	13	28	40	99	34	66
		V Future survival, basal area, and volume yields predicted from current stems per acre								
S.P.A.	99	1.5	90	99	91	100	100	100	62	38
B.A.	79	2.9	38	78	81	98	100	100	50	50
V_o	86	3.0	34	81	5	13	27	81	49	51
V_i	90	2.8	35	81	7	18	41	90	50	50
V_{4o}	88	5.6	42	80	7	18	36	84	45	55
V_{4i}	92	5.5	39	82	14	26	48	94	44	56

[1] S.P.A. = stems per acre, B.A. = basal area, V_o = total volume outside bark, V_i = total volume inside bark, V_{4o} = merchantable volume outside bark, and V_{4i} = merchantable volume inside bark.
[2] Based on data from 436 yield observations.
[3] Based on data from 176 remeasurements at 3- to 5-year intervals.

(Table 2, section I). Average errors were considerably higher when estimated basal areas were used because equation (7) was not highly efficient in estimating stand basal area. The user may get better results than we did by substituting his own survival estimate into the system to predict yields from planting density. For the 176 remeasurements, yields were forecast with 86 to 96 percent of the variation explained (Table 2, sections IV and V).

Volumes by Diameter Classes

To find the proportion of the volumes in each diameter class, volume was assumed to be a linear function of basal area. Requirements of the relationship were that constraints of (9) should not be violated for any diameter class and the relationship should be dependent on stand age, site index, and basal area per acre. The first requirement was satisfied by having one slope coefficient for all outside bark equations and another for all inside bark equations. This presumes that volume per tree above the 4-inch top is constant for all diameter classes on each plot. Although top volumes are sometimes inversely correlated with diameter, use of separate linear regression coefficients for different top diameter limits could cause the regression lines to cross and violate constraints of (9). Constant upper stem volumes were considered less undesirable. The second requirement was satisfied by forcing the equations to go through the average volume per tree for trees of average basal area.

Equations were fitted with data from 1,245 trees randomly selected from 73 plots. Statistical tests revealed no significant difference in slope coefficients for either the inside- or outside-bark regressions at the 0.05 level, which justified the presumption of constant top volume. Coefficients are $\hat{\beta}_1 = 33.718518$ for outside bark and $\hat{\beta}_2 = 25.169762$ for inside bark volumes. The fitted equations accounted for 95 percent or more of the pooled variation about mean plot volumes.

After common slopes were computed and tested, intercepts were determined to minimize the sum of squared deviations between average volume per tree and predicted volumes for trees of average basal area. For given values of stand volumes, basal area, and live trees per acre the resulting estimates are:

$$\hat{\alpha}_1 = \{V_o + V_i - (\hat{\beta}_1 + \hat{\beta}_2) B\} / 2N_t$$

$$\hat{\alpha}_2 = \{V_{4o} + V_{4i} - (\hat{\beta}_1 + \hat{\beta}_2) B\} / 2N_t.$$

Another constraint required the intercept for merchantable volume on the basal area axis to equal or exceed that for total volume and for both to equal or exceed 0.

Volume to Other Top Limits

To provide further utility in the system, volumes to 2-inch and 3-inch tops were calculated by interpolation under the assumption that boles are conic above the 4-inch diameter. The outside bark diameter of 4 inches, outside bark volumes, and the formula for the volume of a cone were used to determine stem length above the 4-inch diameter. This length, inside bark volumes, and the formula for cone volume were then used to obtain inside bark diameter at the 4-inch outside bark diameter point. All necessary information was than available to determine interpolated outside and inside bark volumes to any intermediate diameter between 0 and 4 inches.

Comparisons

This system has two desirable features not available in other diameter-distribution yield tables. First, volume yields may be predicted accurately from either observed basal area or stems per acre, which makes the system more versatile than those restricted to one measure of stand density. Second, future conditions may be forecast directly from present density without involving initial planting spacing.

Predictions of volume yields per acre from this system are more precise than those in other studies. Coefficients of determination (R^2) were 98 percent when yields were estimated from observed basal area and ranged from 92 to 94 percent when estimated from stems per acre. Values of R^2 were 85 percent for shortleaf and 91 percent for loblolly pine merchant-

able yields estimated from observed stems per acre in similar studies (Smalley and Bailey 1974a and 1974b). Average errors for most yield estimates were less than those for old-field plantations of loblolly (Lenhart and Clutter 1971, Lenhart 1972) or slash pine (Bennett 1972).

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STAND AND STOCK TABLES

The tables that follow are consistent with known growth and yield of longleaf pine plantations that are 15 to 40 years old and 40 to 70 feet in site index. Some trends are:

Survival.--Survival percentages increased directly with site index and decreased with planting density and age (fig. 1). Stands that initiated height growth soon after planting had tall trees, high site indices, and high survival. A prolonged grass stage, unique to longleaf pine, resulted in short trees and poor survival at any age. The relationship of survival to site was opposite that reported for other species (Smalley and Bailey 1974a and 1974b).

Basal area.--Total basal area of all trees increased directly with site and age at all planting densities and with planting density and age on all sites (fig. 2).

Quadratic mean diameter.--Mean diameters increased directly with age and decreased with stand density on all sites (fig. 3). They were more closely related to number of survivors than to number of trees planted. Diameters generally increased with site index but occasionally decreased on the best sites, probably because there were more stems per acre. Diameter distributions may be more useful than mean diameters in many situations.

Yields.--Total and merchantable cubic-foot yields increased with site index, age, and planting density (fig. 4). A 10-foot increase in site index doubled early yields. Volumes per acre were low at age 20 years but doubled or tripled by age 30 and nearly doubled again by age 40. Net yield and mean annual increment had not culminated to age 40 years for any site or planting density.

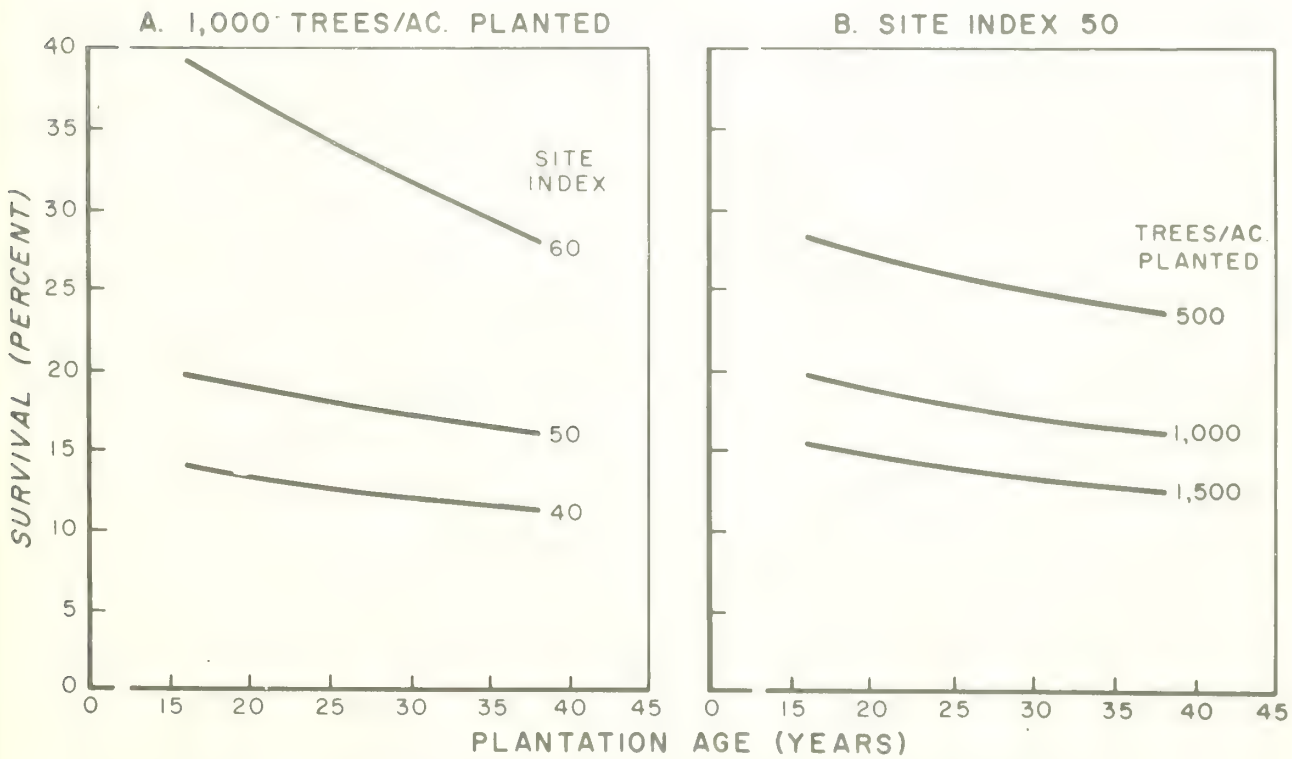

Figure 1.—Survival related to age for different sites (A) and planting densities (B).

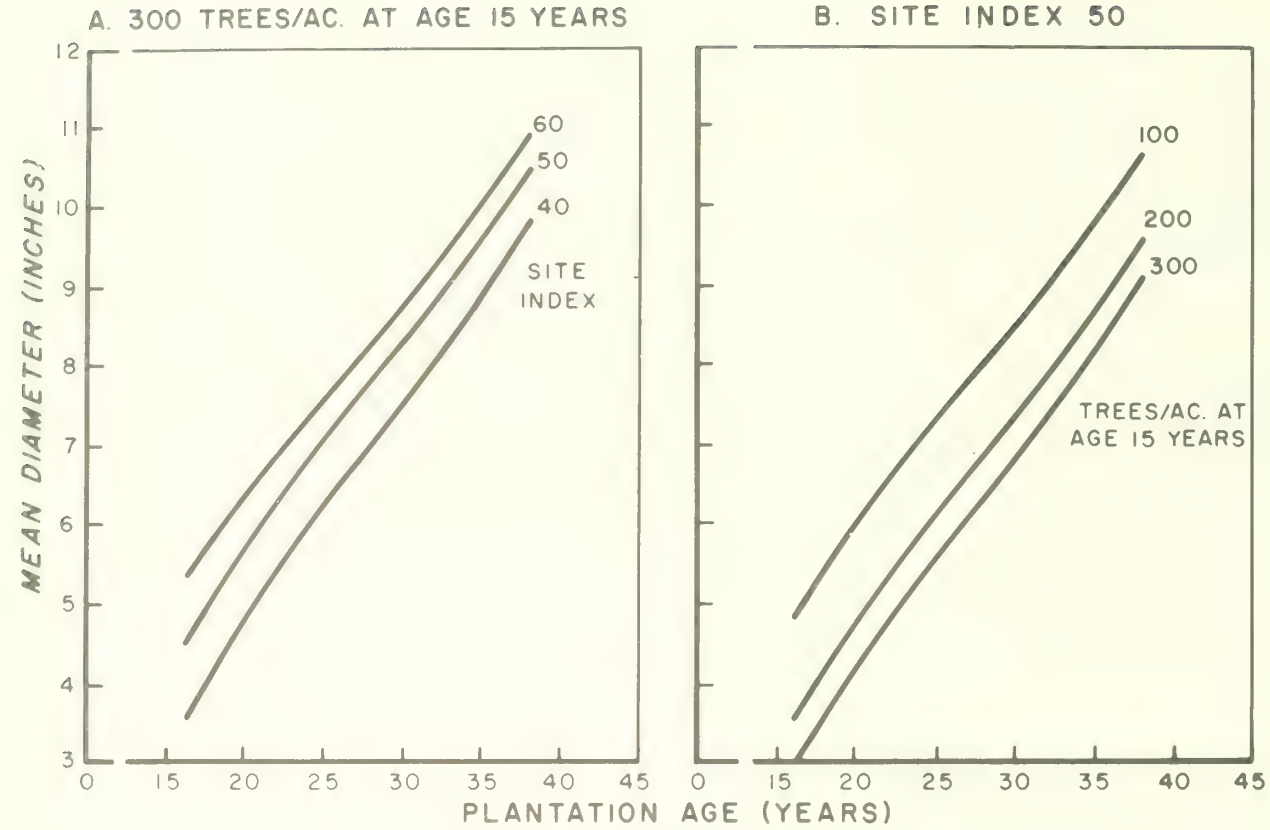

Figure 2.—Total basal area per acre related to age for different sites (A) and planting densities (B).

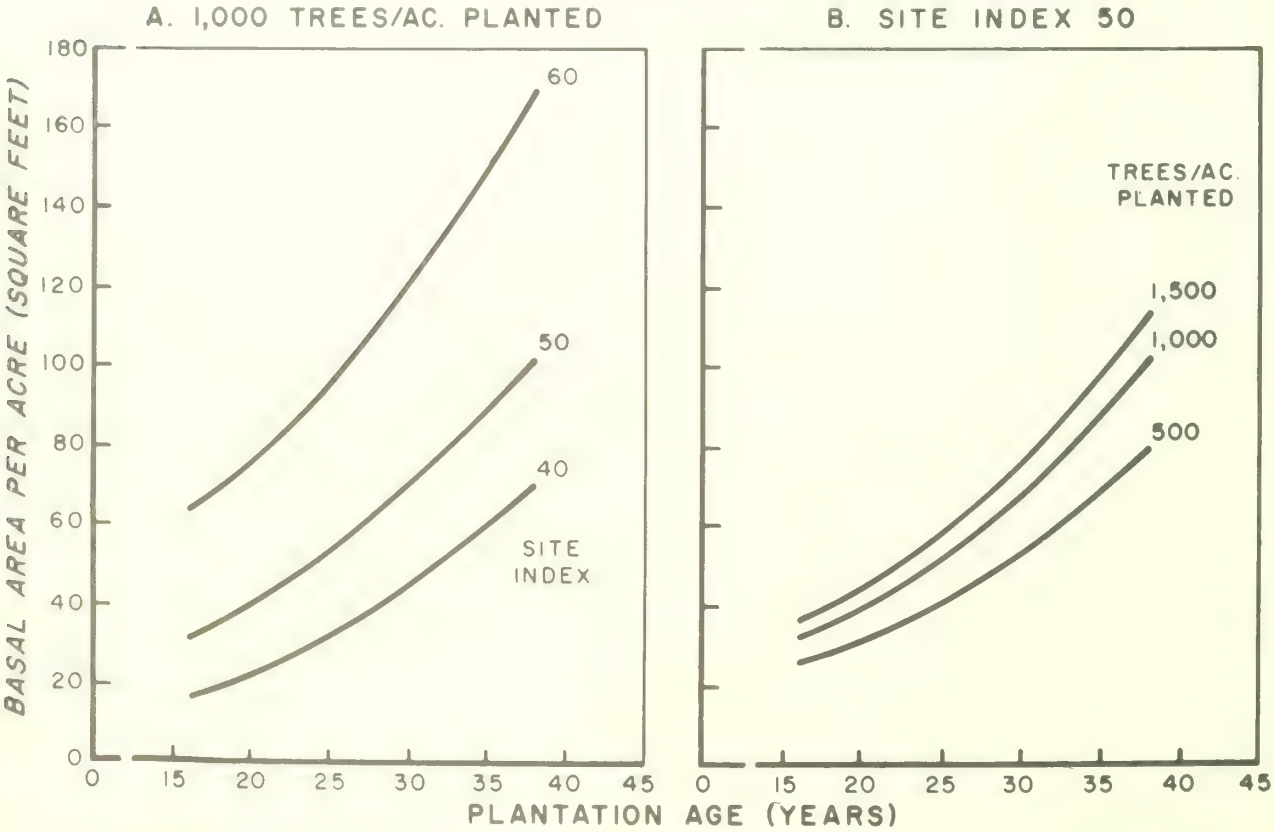

Figure 3.—Quadratic mean diameter related to age for different sites (A) and stand densities at age 15 years (B).

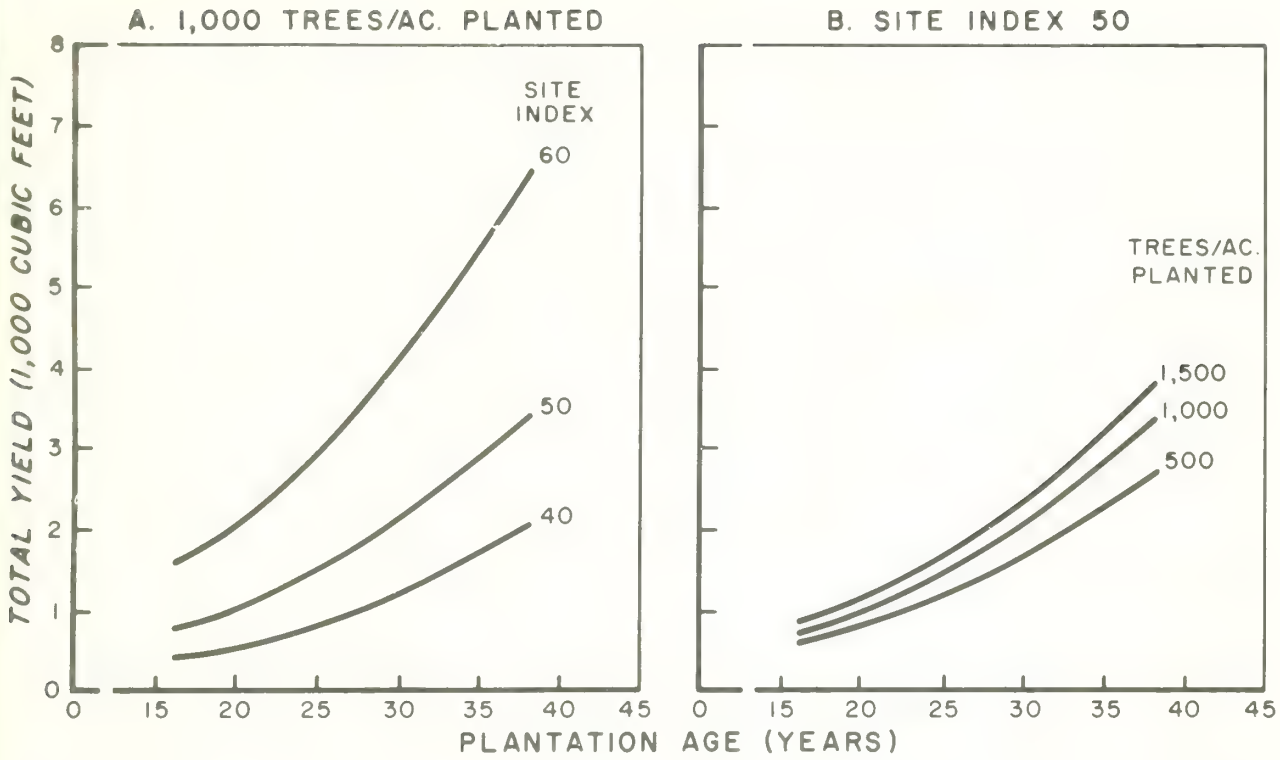

Figure 4.—Total yield per acre of entire stem (outside bark) of all trees related to age for different sites (A) and planting densities (B).

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100 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
15	23	1	10	.1	0	0						
		2	19	.4	0	0						
		3	25	1.2	6	0						
		4	21	1.8	26	14	25	13	22	11	17	8
		5	14	1.9	35	23	34	22	31	20	26	16
		6	7	1.4	29	20	28	19	26	18	22	15
		7	3	.8	18	13	18	13	16	12	14	10
		8	1	.3	8	6	8	6	7	5	6	4
			100	7.9	122	76	113	73	102	66	85	53
			MEAN DIA. 3.8 INCHES. WEIBULL PARAMETERS A= .0, B= 3.91, C= 2.35									
20	33	2	3	.1	0	0						
		3	7	.3	0	0						
		4	13	1.2	4	0	3	0	2	0	0	0
		5	18	2.5	33	14	32	13	28	9	21	3
		6	21	4.2	79	50	77	48	72	44	62	36
		7	17	4.6	102	72	100	71	95	67	85	60
		8	11	3.9	95	70	93	69	90	67	82	62
		9	5	2.2	57	43	56	43	54	42	50	40
		10	1	.6	15	11	15	11	14	11	13	10
			96	19.5	385	260	376	255	355	240	313	211
			MEAN DIA. 6.1 INCHES. WEIBULL PARAMETERS A= .0, B= 6.48, C= 3.61									
25	40	2	1	.0	0	0						
		3	2	.1	0	0						
		4	5	.4	0	0	0	0	0	0	0	0
		5	10	1.4	15	5	14	4	12	3	9	0
		6	14	2.8	49	28	48	27	45	25	39	20
		7	17	4.6	98	67	96	66	93	62	85	56
		8	17	5.9	142	104	140	103	137	99	129	93
		9	13	5.8	148	111	146	110	143	108	136	103
		10	8	4.4	117	90	116	89	114	88	109	85
		11	3	2.0	55	43	55	43	54	42	52	41
		12	1	.8	23	18	23	18	22	18	21	17
			91	28.1	647	466	638	460	620	445	580	415
			MEAN DIA. 7.5 INCHES. WEIBULL PARAMETERS A= .0, B= 7.99, C= 3.98									
30	46	3	1	.0	0	0						
		4	3	.3	0	0	0	0	0	0	0	0
		5	5	.7	8	2	8	2	7	1	5	0
		6	9	1.6	28	16	28	16	26	14	24	12
		7	11	2.9	63	43	62	42	61	40	58	37
		8	13	4.5	109	79	108	78	106	76	101	73
		9	18	7.1	182	136	181	135	178	133	172	129
		10	12	6.5	177	135	176	134	174	133	170	130
		11	9	5.9	165	128	164	128	163	126	160	124
		12	5	3.9	112	88	112	88	111	87	109	85
		13	2	1.8	54	42	54	42	53	42	52	41
		14	1	1.1	32	25	32	25	32	25	31	24
			86	36.3	930	694	925	690	911	677	882	655
			MEAN DIA. 8.8 INCHES. WEIBULL PARAMETERS A= .0, B= 9.35, C= 4.02									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft* 2	*Ft* 3							
35	51	3	1	.0	0	0						
		4	2	.2	0	0	0	0	0	0	0	0
		5	3	.4	5	2	5	2	5	1	4	0
		6	5	1.0	19	11	19	11	18	10	17	9
		7	7	1.9	42	29	42	29	41	28	39	26
		8	9	3.2	78	57	78	57	77	56	75	54
		9	11	4.9	129	96	128	95	127	94	125	92
		10	11	6.1	166	127	165	127	164	126	162	124
		11	11	7.4	209	162	208	161	207	160	204	158
		12	9	7.2	208	163	208	163	208	161	204	159
		13	6	5.6	165	131	165	131	164	130	163	129
		14	4	4.3	130	103	130	103	129	103	128	102
		15	2	2.5	75	60	75	60	75	60	74	59
		16	1	1.4	43	34	43	34	43	34	43	34
			82	46.2	1269	975	1266	973	1256	963	1238	946
			MEAN DIA. 10.2 INCHES, WEIBULL PARAMETERS A= .0, B= 10.79, C= 3.88									
40	56	3	1	.0	0	0						
		4	1	.1	0	0	0	0	0	0	0	0
		5	2	.3	4	1	4	1	4	1	3	1
		6	3	.6	12	7	12	7	12	7	11	6
		7	4	1.1	24	17	24	17	24	17	23	16
		8	6	2.1	53	38	53	38	52	37	50	36
		9	7	3.1	83	63	83	63	82	62	81	61
		10	8	4.4	122	93	122	93	121	92	119	91
		11	10	6.7	190	147	190	147	188	146	185	144
		12	9	7.1	208	163	208	163	207	162	205	160
		13	8	7.4	221	174	221	174	219	173	217	171
		14	7	7.5	227	179	227	179	226	178	224	177
		15	5	6.2	188	149	188	149	187	149	186	148
		16	4	5.6	172	138	172	138	172	137	171	136
		17	2	3.2	98	78	98	78	98	78	97	78
		18	1	1.8	55	45	55	45	55	45	55	44
		19	1	2.0	62	50	62	50	62	50	61	50
			79	59.3	1719	1342	1719	1342	1709	1334	1689	1319
			MEAN DIA. 11.7 INCHES, WEIBULL PARAMETERS A= .0, B= 12.44, C= 3.67									

SI 40

200 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
15	23	1	56	.3	0	0						
		2	52	1.1	0	0						
		3	42	2.1	25	11						
		4	26	2.3	39	24	38	23	36	21	31	18
		5	14	1.9	38	24	37	23	35	22	32	19
		6	8	1.2	25	17	24	17	23	16	21	14
		7	3	.8	17	12	17	12	16	11	15	10
		8	1	.3	8	5	8	5	8	5	7	5
			200	10.0	152	93	124	80	118	75	106	66
			MEAN DIA. 3.0 INCHES, WEIBULL PARAMETERS A= .0, B= 2.90, C= 1.70									
20	33	1	4	.0	0	0						
		2	12	.3	0	0						
		3	25	1.2	0	0						
		4	36	3.2	30	7	28	6	22	4	12	0
		5	40	5.5	93	56	90	53	83	47	69	34
		6	34	6.7	142	98	139	95	131	90	116	77
		7	23	6.2	146	106	143	104	136	99	123	90
		8	11	3.9	97	72	95	71	92	69	84	64
		9	4	1.8	47	35	46	35	44	34	41	32
		10	1	.5	14	12	14	12	14	11	13	10
			190	29.2	569	386	555	376	522	353	458	307
			MEAN DIA. 5.3 INCHES, WEIBULL PARAMETERS A= .0, B= 5.59, C= 3.02									
25	40	1	1	.0	0	0						
		2	4	.1	0	0						
		3	10	.5	0	0						
		4	18	1.6	0	0	7	0	5	0	0	0
		5	26	3.6	53	26	51	24	46	19	37	10
		6	31	6.1	122	79	119	77	113	71	101	60
		7	32	8.6	198	141	195	139	188	133	174	121
		8	26	9.1	228	170	225	168	219	163	207	154
		9	18	7.1	188	143	186	142	182	138	174	132
		10	8	4.4	120	93	119	92	117	91	112	88
		11	3	2.0	56	43	56	43	55	43	53	42
		12	1	.8	23	18	23	18	22	18	21	17
			176	43.7	956	713	981	703	947	676	879	624
			MEAN DIA. 6.7 INCHES, WEIBULL PARAMETERS A= .0, B= 7.15, C= 3.47									
30	46	2	2	.0	0	0						
		3	5	.2	0	0						
		4	6	.8	3	0	3	0	2	0	0	0
		5	15	2.0	29	13	28	12	26	9	21	4
		6	21	4.1	80	51	79	50	75	46	69	40
		7	25	6.7	153	108	151	106	147	102	139	94
		8	25	8.7	219	161	217	159	213	156	204	148
		9	23	10.2	270	205	268	203	264	200	255	192
		10	18	9.8	272	209	270	208	267	205	259	201
		11	11	7.3	207	161	206	160	203	158	198	155
		12	6	4.7	137	108	136	108	135	107	132	105
		13	2	1.8	55	43	55	43	54	43	53	42
		14	1	1.1	32	25	32	25	32	25	31	25
			163	57.6	1457	1084	1445	1074	1418	1051	1361	1005
			MEAN DIA. 8.0 INCHES, WEIBULL PARAMETERS A= .0, B= 8.53, C= 3.58									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
35	51	2	1	.0	0	0						
		3	3	.1	0	0						
		4	5	.4	1	0	1	0	1	0	0	0
		5	9	1.2	17	7	16	7	15	5	13	3
		6	13	2.6	51	32	50	31	48	29	43	26
		7	16	4.3	99	69	98	68	96	66	91	61
		8	19	6.7	168	124	167	123	164	120	158	114
		9	21	9.4	250	189	249	188	245	185	239	179
		10	20	11.0	306	236	305	235	301	232	295	226
		11	17	11.3	324	251	323	250	320	248	314	244
		12	13	10.3	301	237	300	236	298	234	294	230
		13	8	7.4	221	174	220	174	219	173	216	171
		14	5	5.4	162	128	162	128	161	128	159	127
		15	2	2.5	75	59	75	59	74	59	73	60
		16	1	1.4	43	34	43	34	43	34	43	34
			153	74.2	2018	1540	2009	1533	1985	1513	1938	1475
			MEAN DIA. 9.4 INCHES. WEIBULL PARAMETERS A= .0. B= 9.99. C= 3.53									
40	56	2	1	.0	0	0						
		3	2	.1	0	0						
		4	3	.3	1	0	1	0	1	0	0	0
		5	5	.7	10	4	10	4	9	3	7	1
		6	8	1.6	31	20	31	19	29	18	27	15
		7	10	2.7	62	43	61	42	59	40	56	37
		8	13	4.5	115	84	114	83	112	81	107	77
		9	15	6.6	177	134	176	133	174	130	169	125
		10	16	8.7	243	187	242	186	239	183	233	178
		11	15	9.9	284	220	283	219	280	217	274	212
		12	15	11.8	345	269	344	268	341	266	335	262
		13	13	12.0	356	281	355	280	353	278	348	274
		14	10	10.7	322	255	321	254	319	253	315	250
		15	7	8.6	261	208	260	207	259	206	256	204
		16	5	7.0	214	171	213	171	212	170	210	169
		17	3	4.7	146	116	146	116	145	116	144	115
		18	2	3.5	110	88	110	88	109	88	108	87
		19	1	2.0	62	49	62	49	61	49	60	48
			144	95.4	2739	2129	2729	2119	2702	2098	2649	2054
			MEAN DIA. 11.0 INCHES. WEIBULL PARAMETERS A= .0. B= 11.67. C= 3.39									

SI 40

300 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
* 15	23	1	113	.6	0	0						
		2	78	1.7	2	0						
		3	53	2.6	37	19						
		4	30	2.6	48	30	47	29	45	27	42	24
		5	15	2.1	42	27	41	26	40	25	37	23
		6	7	1.4	29	20	29	20	28	19	26	17
		7	3	.8	18	12	18	12	17	12	16	11
		8	1	.4	8	5	8	5	8	5	7	5
			300	12.2	184	113	143	92	138	88	128	80
			MEAN DIA. 2.7 INCHES, WEIBULL PARAMETERS A= .0, B= 2.50, C= 1.50									
20	33	1	10	.1	0	0						
		2	29	.6	0	0						
		3	48	2.4	0	0						
		4	59	5.1	68	28	62	25	54	18	38	4
		5	55	7.5	142	90	138	87	128	79	108	64
		6	41	8.0	179	124	175	121	165	115	146	102
		7	24	6.4	156	113	153	111	145	107	131	98
		8	11	3.8	98	73	96	72	92	70	84	65
		9	4	1.8	47	36	46	36	44	34	40	32
		10	1	.5	15	11	15	11	14	11	13	11
			282	36.2	703	475	685	463	642	434	560	376
			MEAN DIA. 4.9 INCHES, WEIBULL PARAMETERS A= .0, B= 5.07, C= 2.69									
25	40	1	2	.0	0	0						
		2	9	.2	0	0						
		3	20	1.0	0	0						
		4	33	2.9	23	1	21	1	16	1	6	0
		5	43	5.8	97	55	94	52	86	44	71	30
		6	46	9.0	190	129	186	126	177	118	160	102
		7	42	11.2	267	194	263	191	254	183	236	167
		8	30	10.4	268	201	265	199	257	193	242	181
		9	18	7.9	213	163	211	161	206	158	196	150
		10	8	4.3	121	93	120	92	117	91	112	88
		11	3	2.0	56	44	56	44	55	43	53	42
		12	1	.8	22	18	22	18	22	18	21	17
			255	55.4	1257	898	1238	884	1190	849	1097	777
			MEAN DIA. 6.3 INCHES, WEIBULL PARAMETERS A= .0, B= 6.66, C= 3.18									
30	46	1	1	.0	0	0						
		2	4	.1	0	0						
		3	9	.4	0	0						
		4	17	1.5	3	0	8	0	5	0	0	0
		5	25	3.4	52	27	50	25	46	21	38	12
		6	33	6.5	132	87	130	85	124	79	113	67
		7	36	9.6	226	161	223	159	217	153	204	141
		8	36	12.5	321	238	318	236	311	230	297	218
		9	29	12.8	344	262	342	260	336	255	324	246
		10	21	11.4	320	246	318	244	313	241	303	234
		11	12	7.9	226	177	225	176	222	174	217	170
		12	6	4.7	137	108	136	108	135	107	132	105
		13	2	1.8	54	43	54	43	53	42	52	41
		14	1	1.1	32	26	32	26	32	26	31	25
			232	73.7	1853	1375	1836	1362	1794	1328	1711	1259
			MEAN DIA. 7.6 INCHES, WEIBULL PARAMETERS A= .0, B= 8.08, C= 3.35									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
35	51	2	2	.0	0	0						
		3	5	.2	0	0						
		4	9	.8	4	0	4	0	2	0	0	0
		5	15	2.1	30	15	23	14	27	11	22	5
		6	20	4.0	80	52	79	50	75	47	68	39
		7	25	6.7	158	111	156	109	152	105	143	97
		8	28	9.9	251	186	249	184	244	179	234	170
		9	30	13.4	361	273	359	271	353	266	341	256
		10	26	14.3	401	309	399	307	393	303	383	294
		11	21	14.0	403	313	401	312	396	308	387	302
		12	15	11.9	349	274	348	273	344	271	338	266
		13	9	8.4	249	197	248	196	246	195	243	192
		14	5	5.4	163	129	163	129	161	128	159	127
		15	2	2.5	76	60	76	60	75	60	74	60
		16	1	1.4	44	35	44	35	43	35	42	34
			213	95.0	2569	1954	2555	1940	2511	1908	2434	1842
			MEAN DIA. 9.0 INCHES. WEIBULL PARAMETERS A= .0, B= 9.57, C= 3.34									
40	56	2	1	.0	0	0						
		3	3	.1	0	0						
		4	5	.4	2	0	2	0	1	0	0	0
		5	9	1.2	17	8	16	7	14	5	10	1
		6	12	2.3	47	30	46	29	43	26	38	20
		7	16	4.3	99	70	98	68	94	65	87	57
		8	19	6.6	168	124	166	122	161	118	152	109
		9	21	9.2	248	188	246	186	241	181	231	172
		10	24	13.0	364	280	362	278	356	272	344	262
		11	21	13.8	397	308	395	306	389	302	378	293
		12	18	14.9	436	341	434	339	428	335	418	327
		13	16	14.7	438	344	436	343	431	339	422	333
		14	12	12.8	385	305	384	304	380	302	374	297
		15	9	11.0	334	266	333	265	330	263	325	260
		16	6	8.3	256	205	255	204	253	203	250	200
		17	3	4.7	146	116	146	116	144	115	142	114
		18	2	3.5	109	88	109	88	108	87	107	86
		19	1	2.0	61	49	61	49	61	49	60	48
			199	123.0	3507	2722	3489	2704	3434	2662	3338	2579
			MEAN DIA. 10.6 INCHES. WEIBULL PARAMETERS A= .0, B= 11.25, C= 3.25									

•••• N O T E ••••

SPECIAL VALUES WERE PROBABLY ASSIGNED TO WEIBULL PARAMETERS DUE TO NEGATIVE OR VERY LOW PREDICTIONS.

SI 50

100 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
15	29	1	1	.0	0	0						
		2	5	.1	0	0						
		3	13	.6	0	0						
		4	20	1.8	13	0	12	0	9	0	3	0
		5	25	3.4	53	26	51	26	46	23	36	15
		6	19	3.8	75	49	73	48	68	44	58	37
		7	11	3.0	67	47	65	46	62	44	54	39
		8	4	1.4	34	25	33	25	31	23	28	21
		9	1	.4	12	9	12	9	11	8	9	7
			100	14.5	254	158	246	154	227	142	188	119
			MEAN DIA. 5.2 INCHES, WEIBULL PARAMETERS A= .0, B= 5.46, C= 3.28									
20	41	2	1	.0	0	0						
		3	3	.1	0	0						
		4	7	.6	1	0	1	0	1	0	0	0
		5	12	1.7	21	7	20	6	17	4	11	0
		6	17	3.4	63	38	61	36	57	32	48	24
		7	21	5.7	127	86	125	84	119	79	107	70
		8	18	6.4	158	112	155	110	150	107	138	99
		9	11	4.9	130	95	128	94	124	92	116	88
		10	5	2.8	76	56	75	56	73	55	69	54
		11	1	.7	19	15	19	15	19	15	18	14
			96	26.3	595	409	584	401	560	384	507	349
			MEAN DIA. 7.1 INCHES, WEIBULL PARAMETERS A= .0, B= 7.53, C= 4.21									
25	50	3	1	.0	0	0						
		4	3	.3	1	0	1	0	1	0	0	0
		5	6	.8	13	6	13	6	11	4	9	2
		6	10	2.0	41	26	40	25	38	23	33	19
		7	14	3.7	89	61	88	60	85	58	79	53
		8	18	6.2	161	116	160	115	156	112	149	106
		9	16	7.0	192	141	191	140	187	138	180	133
		10	12	6.5	185	138	184	137	181	136	175	133
		11	7	4.6	133	101	132	101	131	100	128	99
		12	3	2.3	70	53	70	53	69	53	67	52
		13	1	.9	28	21	28	21	28	21	27	21
			91	34.4	913	663	907	658	887	645	847	618
			MEAN DIA. 8.3 INCHES, WEIBULL PARAMETERS A= .0, B= 8.85, C= 4.42									
30	59	3	1	.0	0	0						
		4	2	.2	2	1	2	1	2	1	2	0
		5	3	.4	9	5	9	5	8	5	7	4
		6	5	1.2	28	20	28	20	27	19	26	18
		7	9	2.4	64	46	64	46	62	45	60	43
		8	12	4.2	117	87	117	87	115	85	113	83
		9	14	6.2	180	135	179	134	177	133	174	131
		10	13	7.1	211	161	210	161	208	159	205	157
		11	11	7.3	220	168	219	168	218	167	215	165
		12	8	6.3	194	149	194	149	192	148	190	146
		13	4	3.7	115	89	115	89	114	88	113	87
		14	2	2.1	68	52	68	52	67	52	66	52
		15	1	1.2	39	30	39	30	39	30	38	30
			86	42.3	1247	943	1244	942	1229	932	1209	916
			MEAN DIA. 9.5 INCHES, WEIBULL PARAMETERS, A= .0, B= 10.09, C= 4.34									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
35	64	4	1	.1	2	1	2	1	2	1	2	1
		5	2	.3	8	5	8	5	8	5	7	5
		6	4	.8	22	17	22	17	22	17	21	16
		7	6	1.6	48	37	48	37	48	36	47	35
		8	8	2.8	86	66	86	66	85	65	84	64
		9	10	4.4	137	106	137	106	136	105	135	104
		10	11	6.0	188	146	188	146	187	145	186	144
		11	10	6.6	209	162	209	162	208	162	206	161
		12	10	7.8	250	195	250	195	249	194	248	193
		13	8	7.3	236	184	236	184	235	184	234	183
		14	6	6.4	205	161	205	161	205	161	204	160
		15	3	3.7	119	92	119	92	119	92	118	93
		16	2	2.8	91	71	91	71	90	71	89	70
		17	1	1.6	51	40	51	40	51	40	51	40
			82	52.1	1652	1283	1652	1283	1645	1278	1632	1269
			MEAN DIA. 10.8 INCHES, WEIBULL PARAMETERS A= .0, B= 11.46, C= 4.13									
40	70	4	1	.1	3	2	3	2	3	2	3	2
		5	1	.1	5	3	5	3	5	3	5	3
		6	2	.4	13	11	13	11	13	11	13	11
		7	4	1.1	36	29	36	29	36	29	36	29
		8	5	1.8	59	46	59	46	59	46	58	47
		9	6	2.7	90	71	90	71	89	71	88	70
		10	8	4.4	147	116	147	116	146	116	145	115
		11	9	6.0	200	158	200	158	200	158	199	158
		12	9	7.1	238	188	238	188	238	188	237	187
		13	9	8.3	279	221	279	221	278	221	277	220
		14	8	8.6	288	228	288	228	287	228	286	227
		15	6	7.4	248	197	248	197	248	197	247	196
		16	5	7.0	235	186	235	186	235	186	234	185
		17	3	4.8	159	126	159	126	159	126	158	126
		18	2	3.6	118	94	118	94	118	94	118	94
		19	1	2.0	66	53	66	53	66	53	66	52
			79	65.2	2184	1729	2184	1729	2180	1729	2170	1722
			MEAN DIA. 12.3 INCHES, WEIBULL PARAMETERS A= .0, B= 13.06, C= 3.86									

SI 50

200 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
15	29	1	10	.1	0	0						
		2	27	.6	0	0						
		3	42	2.0	2	0						
		4	45	3.9	51	23	48	21	43	17	31	8
		5	37	5.0	93	57	90	55	82	50	68	41
		6	23	4.5	97	64	94	63	88	59	75	52
		7	11	2.9	69	47	67	46	63	44	54	39
		8	4	1.4	34	24	33	24	31	22	27	20
		9	1	.4	11	8	11	8	10	8	9	7
			200	20.7	357	223	343	217	317	200	264	167
			MEAN DIA. 4.4 INCHES. WEIBULL PARAMETERS A= .0. B= 4.54. C= 2.64									
20	41	1	1	.0	0	0						
		2	5	.1	0	0						
		3	12	.6	0	0						
		4	23	2.0	14	0	12	0	8	0	0	0
		5	34	4.6	75	39	72	36	65	30	51	17
		6	39	7.7	161	105	157	102	148	94	130	79
		7	35	9.4	225	157	221	154	211	147	192	134
		8	24	8.4	217	157	214	155	206	150	191	141
		9	12	5.3	144	107	142	106	138	104	130	99
		10	4	2.2	61	46	60	46	59	45	56	43
		11	1	.7	19	14	19	14	18	14	17	14
			190	40.9	916	625	897	613	853	584	767	527
			MEAN DIA. 6.3 INCHES. WEIBULL PARAMETERS A= .0. B= 6.66. C= 3.61									
25	50	2	2	.0	0	0						
		3	5	.2	0	0						
		4	11	1.0	9	1	8	1	5	1	2	0
		5	19	2.6	46	26	44	24	41	21	33	14
		6	27	5.3	119	78	117	76	111	71	100	62
		7	31	8.3	208	147	205	145	198	139	185	129
		8	31	10.1	291	213	288	211	281	205	267	195
		9	25	11.1	310	232	308	230	302	226	290	218
		10	15	8.2	237	179	235	178	232	176	224	172
		11	7	4.6	137	104	136	104	134	103	131	101
		12	2	1.6	48	36	48	36	47	36	45	35
		13	1	.9	28	22	28	22	28	22	27	21
			176	54.6	1433	1038	1417	1027	1380	1000	1304	947
			MEAN DIA. 7.5 INCHES. WEIBULL PARAMETERS A= .0. B= 8.01. C= 3.89									
30	58	2	1	.0	0	0						
		3	3	.1	0	0						
		4	6	.5	3	3	3	3	2	2	1	1
		5	10	1.4	29	19	28	18	27	16	24	13
		6	16	3.1	78	55	77	54	75	52	70	47
		7	22	5.9	158	115	157	114	153	111	147	106
		8	25	8.7	248	184	246	183	242	179	234	173
		9	25	11.0	324	244	322	243	318	239	310	233
		10	22	12.0	360	274	358	273	355	271	347	266
		11	18	10.5	322	247	321	246	318	244	312	241
		12	10	7.8	243	186	242	186	240	185	236	184
		13	5	4.6	143	111	143	111	142	110	140	109
		14	2	2.1	67	53	67	53	67	53	66	52
			163	67.9	1980	1491	1969	1484	1944	1462	1891	1425
			MEAN DIA. 8.7 INCHES. WEIBULL PARAMETERS A= .0. B= 9.28. C= 3.90									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
35	64	2	1	.0	0	0						
		3	.2	.1	2	1						
		4	4	.3	8	5	8	5	8	5	7	4
		5	8	.8	22	15	22	15	21	14	20	13
		6	10	2.0	56	41	56	41	55	40	53	38
		7	14	3.8	112	85	111	84	109	83	106	80
		8	17	5.9	181	138	180	137	178	136	175	133
		9	20	8.9	274	211	273	210	271	208	266	204
		10	19	10.4	325	252	324	251	322	249	317	246
		11	19	12.6	398	309	397	308	394	306	389	303
		12	16	12.6	401	312	400	311	398	310	394	307
		13	11	10.2	325	253	324	253	323	252	320	250
		14	7	7.5	241	188	241	188	240	188	238	187
		15	4	4.9	159	124	159	124	158	124	156	123
		16	2	2.8	90	70	90	70	90	70	90	70
		17	1	1.6	51	40	51	40	51	40	51	39
			153	84.3	2645	2044	2636	2037	2618	2025	2582	1997
			MEAN DIA. 10.1 INCHES. WEIBULL PARAMETERS A= .0, B= 10.67, C= 3.77									
40	70	3	1	.0	2	1						
		4	2	.2	6	4	6	4	6	4	5	4
		5	4	.5	18	14	18	14	18	13	17	12
		6	6	1.2	39	31	39	31	38	30	37	28
		7	9	2.4	79	63	79	63	78	61	76	59
		8	11	3.8	127	100	127	100	125	99	123	97
		9	13	5.7	190	150	189	149	188	148	185	145
		10	15	8.2	270	213	269	212	267	211	264	209
		11	18	11.9	393	309	392	308	390	307	385	304
		12	16	12.6	415	328	414	327	412	326	409	323
		13	14	12.9	426	336	425	336	423	334	420	332
		14	12	12.8	424	334	423	334	421	333	418	331
		15	9	11.0	365	288	365	288	363	287	361	285
		16	6	8.4	277	218	277	218	276	218	274	217
		17	4	6.3	209	164	209	164	208	164	206	163
		18	2	3.5	117	92	117	92	116	92	115	91
		19	1	2.0	65	52	65	52	65	52	65	51
		20	1	2.2	72	57	72	57	72	57	71	57
			144	105.6	3494	2754	3486	2749	3466	2736	3431	2708
			MEAN DIA. 11.6 INCHES. WEIBULL PARAMETERS A= .0, B= 12.29, C= 3.58									

SI 50

300 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
15	29	1	31	.2	0	0						
		2	57	1.2	0	0						
		3	70	3.4	21	0						
		4	62	5.4	85	47	82	45	74	39	59	27
		5	43	5.9	118	77	115	74	107	68	91	56
		6	23	4.5	101	69	98	67	93	63	81	55
		7	10	2.7	64	45	63	44	59	41	52	36
		8	3	1.0	26	19	26	19	24	18	22	16
		9	1	.4	12	8	12	8	11	8	9	7
			300	24.8	427	265	396	257	368	237	314	197
			MEAN DIA. 3.9 INCHES, WEIBULL PARAMETERS A= .0, B= 3.98, C= 2.27									
20	41	1	3	.0	0	0						
		2	12	.3	0	0						
		3	27	1.3	0	0						
		4	44	3.8	40	10	37	9	29	6	14	0
		5	56	7.6	139	80	134	76	123	66	100	47
		6	55	10.8	241	162	235	158	222	147	196	127
		7	43	11.5	285	202	280	198	268	190	244	174
		8	26	9.1	241	176	237	174	228	168	211	158
		9	11	4.9	134	100	132	99	128	97	119	92
		10	4	2.2	62	47	61	47	59	46	56	44
		11	1	.7	19	15	19	15	19	15	18	14
			282	52.1	1161	792	1135	776	1076	735	958	656
			MEAN DIA. 5.8 INCHES, WEIBULL PARAMETERS A= .0, B= 6.15, C= 3.27									
25	50	1	1	.0	0	0						
		2	4	.1	0	0						
		3	11	.5	0	0						
		4	21	1.8	20	5	18	5	15	3	8	0
		5	33	4.5	86	51	83	48	77	42	64	30
		6	43	8.5	197	134	193	131	184	123	167	107
		7	47	12.6	325	233	320	229	309	221	288	204
		8	41	14.4	394	289	390	286	380	279	360	266
		9	29	12.9	367	275	364	273	356	268	341	259
		10	16	8.8	258	194	256	193	251	191	241	187
		11	7	4.6	139	106	138	105	136	104	131	102
		12	2	1.6	48	37	48	37	47	36	46	35
			255	70.3	1834	1325	1810	1307	1755	1267	1646	1190
			MEAN DIA. 7.1 INCHES, WEIBULL PARAMETERS A= .0, B= 7.54, C= 3.61									
30	58	2	2	.0	0	0						
		3	5	.2	1	0						
		4	11	1.0	15	7	14	6	12	4	9	1
		5	19	2.6	57	37	56	36	52	32	48	26
		6	27	5.3	134	95	132	93	127	89	118	80
		7	34	9.1	248	181	246	179	240	174	228	164
		8	37	12.9	370	276	367	274	360	268	347	258
		9	34	15.0	444	336	441	334	434	329	421	319
		10	28	15.3	462	351	460	350	454	346	442	339
		11	19	12.5	384	295	382	294	379	292	371	287
		12	10	7.9	244	188	243	188	241	186	236	184
		13	4	3.7	115	90	115	90	114	89	112	87
		14	2	2.1	67	53	67	53	67	53	66	52
			232	87.7	2541	1909	2523	1897	2480	1862	2396	1797
			MEAN DIA. 8.3 INCHES, WEIBULL PARAMETERS A= .0, B= 8.83, C= 3.67									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
35	64	2	1	.0	0	0						
		3	3	.1	2	1						
		4	6	.5	12	8	12	8	11	7	9	5
		5	11	1.5	39	29	38	28	37	26	34	23
		6	16	3.1	88	65	87	64	85	62	80	58
		7	22	5.8	173	131	172	130	168	126	161	120
		8	26	9.0	274	209	272	207	268	204	260	197
		9	28	12.3	380	292	378	290	373	287	364	279
		10	28	15.2	475	366	473	365	468	361	459	354
		11	25	16.4	518	401	516	400	512	397	503	391
		12	19	14.8	472	366	470	365	467	363	460	358
		13	13	11.9	381	297	380	296	377	294	372	291
		14	8	8.5	273	213	272	213	271	212	268	210
		15	4	4.9	157	123	157	123	156	123	155	122
		16	2	2.8	89	70	89	70	89	70	88	69
		17	1	1.6	51	40	51	40	51	40	50	39
			213	108.5	3384	2611	3367	2599	3333	2572	3263	2516
			MEAN DIA. 9.7 INCHES, WEIBULL PARAMETERS A= .0, B= 10.25, C= 3.58									
40	70	2	1	.0	1	1						
		3	2	.1	3	2						
		4	4	.4	12	9	12	9	11	8	9	6
		5	7	1.0	31	25	30	24	29	23	26	20
		6	10	2.0	65	51	64	50	62	48	58	45
		7	14	3.8	124	97	123	96	120	94	115	89
		8	17	6.0	196	154	195	153	191	150	185	144
		9	20	8.9	292	230	290	229	286	225	278	218
		10	22	12.1	397	312	395	310	391	307	382	299
		11	21	13.9	459	361	457	360	453	356	444	349
		12	21	16.6	546	429	544	428	540	424	531	418
		13	18	16.7	549	432	547	431	544	428	536	423
		14	15	16.1	531	418	530	417	526	415	520	411
		15	11	13.6	447	351	446	350	444	349	439	346
		16	7	9.8	323	255	322	255	321	253	318	251
		17	5	7.9	261	205	260	205	259	204	257	203
		18	2	3.6	117	92	117	92	117	92	116	92
		19	1	2.0	65	52	65	52	65	52	65	51
		20	1	2.2	73	57	73	57	72	57	71	56
			199	136.5	4492	3533	4470	3518	4431	3485	4350	3421
			MEAN DIA. 11.2 INCHES, WEIBULL PARAMETERS A= .0, B= 11.88, C= 3.43									

SI 50

400 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
15	29	1	64	.3	0	0						
		2	90	2.0	0	0						
		3	92	4.5	42	11						
		4	72	6.2	107	63	104	60	95	54	79	42
		5	45	6.1	126	83	123	80	115	75	101	63
		6	23	4.5	101	70	99	68	94	64	84	56
		7	10.	2.7	63	44	62	43	59	41	53	36
		8	3	1.0	26	18	25	18	24	17	21	15
		9	1	.4	11	8	11	8	11	8	10	7
			400	27.8	476	297	424	277	398	259	348	219
			MEAN DIA. 3.6 INCHES, WEIBULL PARAMETERS A= .0, B= 3.57, C= 2.02									
20	41	1	6	.0	0	0						
		2	22	.5	0	0						
		3	45	2.2	0	0						
		4	66	5.8	73	28	68	24	57	16	34	0
		5	76	10.4	202	124	195	118	180	105	149	80
		6	60	13.4	310	211	303	206	286	195	253	172
		7	48	12.8	327	234	321	230	307	221	279	204
		8	26	9.1	245	179	241	177	231	172	213	162
		9	11	4.9	136	101	134	100	129	98	120	94
		10	3	1.6	47	35	46	35	45	34	42	33
		11	1	.7	19	15	19	15	18	15	17	14
			372	61.3	1359	927	1327	905	1253	856	1107	759
			MEAN DIA. 5.5 INCHES, WEIBULL PARAMETERS A= .0, B= 5.79, C= 3.04									
25	50	1	2	.0	0	0						
		2	7	.2	0	0						
		3	18	.9	0	0						
		4	33	2.9	37	13	34	11	28	8	16	0
		5	48	6.5	131	81	127	77	117	60	98	49
		6	58	11.4	271	187	266	182	253	171	228	150
		7	59	15.8	413	297	407	292	393	282	365	261
		8	48	16.7	464	343	459	339	446	331	421	314
		9	32	14.1	406	305	402	303	393	297	375	286
		10	16	8.7	258	195	256	194	250	191	240	186
		11	7	4.6	139	106	138	105	136	104	131	102
		12	2	1.6	47	37	47	37	46	37	45	36
			330	83.4	2166	1564	2136	1540	2062	1489	1919	1384
			MEAN DIA. 6.8 INCHES, WEIBULL PARAMETERS A= .0, B= 7.21, C= 3.41									
30	58	1	1	.0	0	0						
		2	3	.1	0	0						
		3	9	.4	2	0						
		4	17	1.5	25	12	24	11	20	8	14	2
		5	27	3.7	83	55	81	53	76	48	66	38
		6	37	7.3	187	133	184	130	177	123	163	110
		7	45	12.1	334	245	330	242	321	234	303	218
		8	48	16.9	486	364	482	361	472	353	452	337
		9	41	18.2	542	410	538	407	529	401	511	389
		10	31	17.0	516	394	513	392	505	388	491	379
		11	20	13.3	409	314	407	313	402	310	392	305
		12	11	8.7	271	209	270	208	267	207	261	204
		13	4	3.7	116	90	116	90	115	89	113	88
		14	1	1.1	34	26	34	26	34	26	33	26
			295	104.1	3005	2252	2979	2233	2918	2187	2799	2096
			MEAN DIA. 8.0 INCHES, WEIBULL PARAMETERS A= .0, B= 8.52, C= 3.51									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
35	64	2	2	.0	0	0						
		3	5	.2	4	1						
		4	9	.8	18	11	17	10	15	9	12	6
		5	16	2.2	58	41	57	40	54	37	48	31
		6	22	4.3	122	91	120	89	116	85	108	77
		7	29	7.7	229	173	227	171	221	165	210	155
		8	34	11.9	360	275	357	273	350	267	337	255
		9	35	15.5	477	366	474	364	467	358	453	347
		10	34	18.5	579	448	576	446	569	440	555	429
		11	29	19.1	604	467	601	465	595	461	582	452
		12	22	17.3	549	426	547	425	542	422	532	416
		13	14	12.9	412	321	411	320	407	318	401	314
		14	8	8.5	275	214	274	214	272	212	268	210
		15	4	4.9	158	124	158	124	156	123	154	121
		16	2	2.8	90	70	90	70	89	70	88	69
		17	1	1.6	51	40	51	40	51	40	50	39
			266	128.3	3986	3068	3960	3051	3904	3007	3798	2921
			MEAN DIA. 9.4 INCHES, WEIBULL PARAMETERS A= .0, B= 9.96, C= 3.46									
40	70	2	1	.0	1	0						
		3	3	.1	5	3						
		4	6	.5	17	12	16	11	15	10	12	7
		5	9	1.2	39	31	38	30	36	28	32	23
		6	13	2.5	83	65	82	64	78	60	71	53
		7	18	4.8	156	122	154	120	149	116	140	107
		8	22	7.6	249	196	247	194	241	188	229	178
		9	25	11.0	359	282	356	280	350	274	337	262
		10	27	14.7	480	377	477	374	469	368	455	356
		11	27	17.8	582	457	579	454	571	449	555	437
		12	25	19.6	642	504	639	502	631	496	616	486
		13	21	19.3	633	498	630	496	624	492	612	483
		14	17	18.1	595	467	593	466	587	462	577	456
		15	12	14.7	482	379	480	378	477	376	469	372
		16	8	11.1	366	287	365	287	362	285	357	283
		17	5	7.9	258	203	257	203	256	202	253	200
		18	3	5.3	173	137	173	137	172	136	170	135
		19	1	2.0	64	50	64	50	64	50	63	51
		20	1	2.2	71	56	71	56	71	56	71	56
			244	160.3	5255	4126	5221	4102	5153	4048	5019	3945
			MEAN DIA. 11.0 INCHES, WEIBULL PARAMETERS A= .0, B= 11.61, C= 3.34									

SI 50

500 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft* 2	*Ft* 3							
15	29	1	109	.6	0	0						
		2	123	2.7	0	0						
		3	110	5.4	62	25						
		4	77	6.7	122	73	119	70	111	65	95	53
		5	45	6.1	130	85	127	83	120	77	107	67
		6	22	4.3	98	66	96	65	92	61	83	55
		7	9	2.4	57	39	56	38	54	36	49	33
		8	4	1.4	34	23	33	23	32	22	29	20
		9	1	.4	11	8	11	8	11	8	10	7
			500	30.0	514	319	442	287	420	269	373	235
			MEAN DIA. 3.3 INCHES, WEIBULL PARAMETERS A= .0, B= 3.24, C= 1.82									
20	41	1	11	.1	0	0						
		2	34	.7	0	0						
		3	64	3.1	2	0						
		4	88	7.7	108	49	102	43	87	29	58	2
		5	94	12.8	262	165	254	159	234	143	195	113
		6	78	15.3	365	251	357	246	336	232	297	207
		7	51	13.6	353	253	346	249	330	240	299	223
		8	26	9.1	248	181	244	179	234	174	214	165
		9	10	4.4	125	93	123	92	118	90	109	85
		10	3	1.6	47	35	46	35	45	35	42	34
		11	1	.7	20	15	20	15	19	14	17	13
			460	69.2	1530	1042	1492	1018	1403	957	1231	842
			MEAN DIA. 5.3 INCHES, WEIBULL PARAMETERS A= .0, B= 5.51, C= 2.87									
25	50	1	3	.0	0	0						
		2	11	.2	0	0						
		3	26	1.3	0	0						
		4	46	4.0	57	24	53	21	43	14	25	0
		5	63	8.6	178	113	172	108	159	95	134	70
		6	74	14.6	356	247	349	241	332	227	298	199
		7	58	18.3	486	352	479	347	461	334	427	309
		8	53	18.6	521	386	515	382	500	372	471	353
		9	33	14.6	425	319	421	317	410	311	390	301
		10	16	8.8	260	198	258	197	252	194	242	189
		11	8	4.0	120	92	119	92	117	91	112	89
		12	2	1.6	49	37	49	37	47	37	45	36
			401	94.6	2452	1768	2415	1742	2321	1675	2144	1546
			MEAN DIA. 6.6 INCHES, WEIBULL PARAMETERS A= .0, B= 6.95, C= 3.27									
30	58	1	1	.0	0	0						
		2	5	.1	0	0						
		3	12	.6	3	0						
		4	23	2.0	34	19	32	17	27	12	18	2
		5	36	4.9	112	75	109	72	101	64	87	50
		6	47	9.3	240	171	235	167	225	157	205	139
		7	55	14.8	410	301	405	297	392	286	368	266
		8	54	19.0	548	411	543	407	530	397	506	378
		9	47	20.9	622	471	617	468	605	460	582	444
		10	34	18.7	566	433	562	431	554	425	537	414
		11	21	13.9	429	330	427	329	421	326	410	320
		12	11	8.7	271	209	270	208	266	206	260	203
		13	4	3.7	117	90	116	90	115	89	112	88
		14	1	1.1	34	26	34	26	34	26	33	26
			351	117.7	3386	2536	3351	2512	3270	2448	3118	2330
			MEAN DIA. 7.8 INCHES, WEIBULL PARAMETERS A= .0, B= 8.30, C= 3.40									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft* 2	*Ft* 3							
35	64	1	1	.0	0	0						
		2	3	.1	0	0						
		3	7	.3	5	2						
		4	12	1.0	23	15	22	14	20	11	15	8
		5	20	2.7	71	51	69	49	65	45	56	36
		6	28	5.5	155	115	152	112	146	107	134	95
		7	35	9.4	276	208	273	205	265	198	249	184
		8	40	14.0	423	323	419	319	410	311	392	295
		9	41	18.1	559	429	555	426	545	418	526	402
		10	38	20.7	648	500	644	497	634	490	616	476
		11	32	21.1	667	516	663	514	655	508	638	497
		12	24	18.8	599	465	596	463	590	459	577	451
		13	15	13.8	442	344	440	343	436	341	428	336
		14	9	9.6	309	241	308	240	305	239	300	236
		15	4	4.9	158	124	158	124	156	123	154	122
		16	2	2.8	90	70	90	70	89	70	88	70
		17	1	1.6	51	40	51	40	50	40	49	39
			312	144.5	4476	3443	4440	3416	4366	3360	4222	3245
			MEAN DIA. 9.2 INCHES. WEIBULL PARAMETERS A= .0. B= 9.75. C= 3.37									
40	70	2	2	.0	1	1						
		3	4	.2	6	4						
		4	7	.6	19	14	18	13	16	11	12	7
		5	12	1.6	52	40	50	38	47	35	39	27
		6	17	3.3	108	83	106	81	100	76	88	66
		7	22	5.9	190	148	187	145	180	139	166	126
		8	26	9.1	295	231	291	228	283	220	266	204
		9	30	13.3	432	338	428	334	418	325	398	308
		10	29	15.8	516	405	512	401	502	393	482	377
		11	31	20.5	669	526	664	522	653	513	632	496
		12	28	22.0	721	566	717	563	706	555	686	541
		13	24	22.1	726	570	722	567	713	561	695	549
		14	18	19.3	632	496	629	494	622	490	608	481
		15	13	16.0	524	411	522	410	517	407	507	401
		16	9	12.6	413	325	412	324	408	322	401	318
		17	5	7.9	259	204	258	203	256	202	252	200
		18	3	5.3	174	137	174	137	172	136	170	135
		19	1	2.0	65	51	65	51	64	51	63	50
		20	1	2.2	71	57	71	57	71	57	70	56
			282	179.6	5873	4607	5826	4568	5728	4493	5535	4342
			MEAN DIA. 10.8 INCHES. WEIBULL PARAMETERS A= .0. B= 11.42. C= 3.27									

SI 60

100 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
15	35	2	2	.0	0	0						
		3	8	.3	0	0						
		4	13	1.1	4	0	3	0	2	0	0	0
		5	20	2.7	37	16	35	15	32	11	24	4
		6	24	4.7	90	53	88	51	82	48	71	40
		7	19	5.1	115	76	113	75	107	71	96	65
		8	11	3.8	95	66	94	65	90	63	83	60
		9	4	1.8	47	33	46	33	44	32	41	30
		10	1	.5	15	11	15	11	14	11	13	10
			100	20.2	403	255	394	250	371	236	328	209
			MEAN DIA. 6.1 INCHES, WEIBULL PARAMETERS A= .0, B= 6.46, C= 3.88									
20	49	3	1	.0	0	0						
		4	4	.3	2	0	2	0	1	0	0	0
		5	8	1.1	18	8	17	7	15	6	11	3
		6	14	2.7	58	36	57	35	54	32	48	27
		7	19	5.0	123	82	121	80	117	77	108	70
		8	20	6.9	182	128	180	126	175	123	166	116
		9	16	7.0	195	139	193	138	189	136	180	132
		10	9	4.9	140	102	139	102	137	100	132	98
		11	4	2.6	77	57	77	57	76	56	74	55
		12	1	.8	23	17	23	17	23	17	22	17
			96	31.4	818	569	809	562	787	547	741	518
			MEAN DIA. 7.7 INCHES, WEIBULL PARAMETERS A= .0, B= 8.23, C= 4.60									
25	60	3	1	.0	0	0						
		4	2	.2	3	2	3	2	3	2	3	1
		5	4	.5	13	9	13	9	13	8	12	7
		6	8	1.6	43	31	43	31	42	29	40	27
		7	12	3.2	93	67	92	67	91	65	88	63
		8	16	5.6	169	123	168	122	166	120	161	117
		9	16	7.1	219	161	218	160	215	159	210	156
		10	15	8.2	257	190	256	189	254	188	249	186
		11	10	6.6	210	157	209	157	208	156	205	154
		12	5	4.0	126	95	126	95	125	95	123	94
		13	2	1.9	60	45	60	45	60	45	59	44
			91	39.0	1193	880	1188	877	1177	867	1150	849
			MEAN DIA. 8.9 INCHES, WEIBULL PARAMETERS A= .0, B= 9.41, C= 4.71									
30	69	4	1	.1	3	2	3	2	3	2	3	2
		5	3	.4	14	10	14	10	14	10	14	10
		6	5	1.0	33	26	33	26	33	26	33	25
		7	7	1.9	63	49	63	49	63	49	62	48
		8	10	3.5	119	91	119	91	118	91	117	90
		9	13	5.7	195	150	195	150	195	149	194	148
		10	14	7.6	260	199	260	199	259	198	257	197
		11	13	8.6	292	224	292	224	291	223	289	222
		12	10	7.8	267	204	267	204	266	204	265	204
		13	6	5.5	188	143	188	143	188	143	187	144
		14	3	3.2	109	84	109	84	109	84	108	83
		15	1	1.2	41	32	41	32	41	32	41	32
			86	46.6	1584	1214	1584	1214	1580	1211	1570	1205
			MEAN DIA. 10.0 INCHES, WEIBULL PARAMETERS A= .0, B= 10.59, C= 4.56									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft* 2	*Ft* 3							
35	77	4	1	.1	3	2	3	2	3	2	3	2
		5	2	.3	10	8	10	8	10	8	10	8
		6	3	.6	22	17	22	17	22	17	22	17
		7	5	1.4	50	40	50	40	50	40	50	40
		8	7	2.5	92	72	92	72	92	72	92	72
		9	9	4.1	149	118	149	118	149	117	148	116
		10	10	5.6	203	161	203	161	203	161	203	161
		11	11	7.4	271	213	271	213	271	213	271	213
		12	11	8.8	323	254	323	254	323	254	323	254
		13	9	8.5	309	243	309	243	309	243	309	243
		14	7	7.6	280	220	280	220	280	220	280	220
		15	4	5.0	183	144	183	144	183	144	183	144
		16	2	2.8	104	81	104	81	104	81	104	81
		17	1	1.6	59	47	59	47	59	47	59	47
			82	56.2	2058	1620	2058	1620	2058	1619	2057	1618
		MEAN DIA. 11.2 INCHES, WEIBULL PARAMETERS A= .0, B= 11.91, C= 4.29										
40	84	4	1	.1	3	2	3	2	3	2	3	2
		5	1	.1	6	4	6	4	6	4	6	4
		6	2	.4	15	12	15	12	15	12	15	12
		7	3	.8	31	25	31	25	31	25	31	25
		8	4	1.4	54	43	54	43	54	43	54	43
		9	6	2.7	104	83	104	83	104	83	104	83
		10	7	3.8	148	119	148	119	148	119	148	119
		11	8	5.3	205	165	205	165	205	165	205	165
		12	9	7.1	275	220	275	220	275	220	275	220
		13	10	9.3	358	287	358	287	358	287	358	287
		14	8	8.6	333	267	333	267	333	267	333	267
		15	7	8.6	334	269	334	269	334	269	334	269
		16	5	7.0	272	218	272	218	272	218	272	218
		17	4	6.3	245	197	245	197	245	197	245	197
		18	2	3.6	137	110	137	110	137	110	137	110
		19	1	2.0	76	62	76	62	76	62	76	62
		20	1	2.2	85	68	85	68	85	68	85	68
			79	69.3	2681	2151	2681	2151	2681	2151	2681	2151
		MEAN DIA. 12.7 INCHES, WEIBULL PARAMETERS A= .0, B= 13.47, C= 3.98										

SI 60

200 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
15	35	1	3	.0	0	0						
		2	12	.3	0	0						
		3	26	1.3	0	0						
		4	39	3.4	33	7	31	6	25	4	15	0
		5	43	5.8	102	57	99	54	91	49	76	37
		6	38	7.4	161	103	157	100	148	95	130	83
		7	24	6.4	154	105	151	103	144	99	130	91
		8	11	3.8	96	70	96	69	93	67	85	62
		9	3	1.3	36	25	35	25	34	24	31	23
		10	1	.5	15	11	15	11	14	11	13	10
			200	30.2	599	378	584	368	549	349	480	306
			MEAN DIA. 5.3 INCHES, WEIBULL PARAMETERS A= .0, B= 5.56, C= 3.23									
20	49	2	2	.0	0	0						
		3	7	.3	0	0						
		4	15	1.3	14	3	13	3	10	2	5	0
		5	26	3.5	67	37	65	35	59	30	49	21
		6	36	7.0	163	107	160	104	152	98	137	85
		7	39	10.4	268	185	264	182	255	176	238	163
		8	33	11.5	316	225	313	223	304	217	288	207
		9	20	8.8	253	183	251	182	245	179	234	174
		10	9	4.9	145	107	144	106	141	105	136	102
		11	3	2.0	60	44	60	44	58	44	56	43
			190	49.8	1286	891	1270	879	1224	851	1143	795
			MEAN DIA 6.9 INCHES, WEIBULL PARAMETERS A= .0, B= 7.37, C= 3.99									
25	60	2	1	.0	0	0						
		3	3	.1	2	0						
		4	7	.6	13	7	12	7	11	6	9	4
		5	14	1.9	48	33	47	32	45	30	42	27
		6	22	4.4	121	86	120	85	116	81	103	75
		7	29	7.8	228	165	226	164	222	160	213	153
		8	34	12.0	361	265	359	263	353	259	343	251
		9	29	12.9	399	295	397	294	392	290	382	284
		10	21	11.5	362	269	360	268	357	266	349	262
		11	11	7.3	232	173	231	173	229	172	225	170
		12	4	3.2	101	76	101	76	100	76	99	75
		13	1	.9	30	22	30	22	30	22	29	23
			176	62.7	1897	1391	1883	1384	1855	1362	1800	1324
			MEAN DIA. 8.1 INCHES, WEIBULL PARAMETERS A= .0, B= 8.58, C= 4.17									
30	69	2	1	.0	1	1						
		3	2	.1	3	2						
		4	4	.3	12	9	12	9	12	9	11	8
		5	8	1.1	37	28	37	28	36	28	35	27
		6	13	2.6	86	65	86	65	85	64	83	62
		7	19	5.1	170	130	170	129	168	128	166	126
		8	24	8.4	282	215	281	214	279	213	276	210
		9	25	11.0	372	283	371	282	369	281	365	278
		10	24	13.1	441	336	440	336	438	334	434	332
		11	19	12.5	422	322	421	322	419	320	416	318
		12	13	10.2	343	262	343	262	342	261	340	260
		13	7	6.5	217	165	217	165	216	165	215	165
		14	3	3.2	108	83	108	83	108	83	107	82
		15	1	1.2	41	32	41	32	41	32	41	32
			163	75.3	2535	1933	2527	1927	2513	1918	2489	1900
			MEAN DIA. 9.2 INCHES, WEIBULL PARAMETERS A= .0, B= 9.78, C= 4.11									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
35	77	3	1	.0	2	1						
		4	3	.3	10	8	10	8	10	8	10	7
		5	5	.7	25	19	25	19	25	19	25	19
		6	8	1.6	58	46	58	46	57	46	56	45
		7	12	3.2	117	92	117	92	117	92	116	91
		8	16	5.6	205	161	205	161	204	160	203	159
		9	19	8.5	307	241	307	241	306	241	305	240
		10	22	12.1	440	344	440	344	439	343	438	342
		11	20	13.4	483	379	483	379	482	379	481	378
		12	17	13.5	490	383	490	383	489	383	487	382
		13	13	12.1	439	344	439	344	439	343	438	342
		14	9	9.7	353	276	353	276	353	276	352	275
		15	5	6.2	225	177	225	177	225	177	224	176
		16	2	2.8	102	80	102	80	102	80	102	80
		17	1	1.6	58	46	58	46	58	46	58	46
			153	91.5	3314	2597	3312	2596	3306	2593	3295	2582
			MEAN DIA. 10.5 INCHES. WEIBULL PARAMETERS A= .0. B= 11.12. C= 3.93									
40	84	3	1	.0	2	1						
		4	2	.2	7	5	7	5	7	5	7	5
		5	3	.4	16	12	16	12	16	12	16	12
		6	5	1.0	37	30	37	30	37	30	37	29
		7	8	2.1	81	65	81	65	81	65	81	64
		8	10	3.5	133	107	133	107	133	107	132	106
		9	12	5.3	202	162	202	162	202	162	201	161
		10	15	8.2	312	249	312	249	312	249	311	249
		11	16	10.5	402	322	402	322	402	322	401	321
		12	16	12.5	479	384	479	384	479	383	478	382
		13	15	13.8	528	421	528	421	527	421	526	421
		14	13	13.9	530	424	530	424	530	424	529	423
		15	10	12.2	468	374	468	374	468	374	467	374
		16	7	9.8	373	298	373	298	373	298	372	298
		17	5	7.9	301	240	301	240	301	240	300	240
		18	3	5.3	202	162	202	162	202	162	202	161
		19	2	3.9	150	120	150	120	150	120	150	120
		20	1	2.2	84	67	84	67	84	67	84	67
			144	112.7	4307	3443	4305	3442	4304	3441	4294	3433
			MEAN DIA. 12.0 INCHES. WEIBULL PARAMETERS A= .0. B= 12.71. C= 3.70									

SI 60

300 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b	I. b	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
15	35	1	9	.0	0	0						
		2	29	.6	0	0						
		3	52	2.5	0	0						
		4	64	5.5	73	29	69	26	61	19	44	6
		5	63	8.5	166	98	161	95	149	87	126	73
		6	45	8.7	200	131	195	128	184	122	163	109
		7	24	6.3	159	108	156	106	148	103	133	95
		8	10	3.5	91	63	89	62	86	60	78	57
		9	3	1.3	36	25	35	25	33	24	30	23
		10	1	.5	15	11	15	11	14	11	13	10
			300	37.6	740	465	720	453	675	426	587	373
			MEAN DIA. 4.8 INCHES. WEIBULL PARAMETERS A= .0. B= 5.03. C= 2.87									
20	49	1	1	.0	0	0						
		2	6	.1	0	0						
		3	16	.8	0	0						
		4	31	2.7	35	13	33	11	27	8	16	0
		5	47	6.4	131	79	127	75	118	67	99	50
		6	58	11.4	277	185	272	181	259	171	235	152
		7	53	14.2	379	265	373	261	360	253	335	236
		8	39	13.7	384	275	380	273	369	267	349	256
		9	21	9.3	272	197	269	196	263	193	251	187
		10	8	4.4	131	97	130	97	127	95	122	93
		11	2	1.3	40	30	40	30	39	30	38	29
			282	64.4	1649	1141	1624	1124	1562	1084	1445	1003
			MEAN DIA. 6.5 INCHES. WEIBULL PARAMETERS A= .0. B= 6.86. C= 3.65									
25	60	2	2	.0	0	0						
		3	7	.3	1	1						
		4	15	1.3	28	17	27	16	25	14	20	9
		5	26	3.5	90	62	88	60	84	57	76	49
		6	37	7.3	203	144	200	142	194	136	182	126
		7	45	12.0	353	256	350	253	342	248	327	236
		8	46	16.0	487	357	484	355	475	349	459	337
		9	37	16.3	506	374	503	372	496	368	482	359
		10	24	13.1	411	307	409	306	404	303	395	297
		11	11	7.2	231	172	230	172	227	170	222	168
		12	4	3.1	101	76	101	76	100	75	98	74
		13	1	.9	30	22	30	22	29	22	28	22
			255	81.2	2444	1788	2422	1774	2376	1742	2289	1677
			MEAN DIA. 7.6 INCHES. WEIBULL PARAMETERS A= .0. B= 8.11. C= 3.89									
30	69	2	1	.0	1	1						
		3	4	.2	7	5						
		4	18	.7	24	18	24	18	23	17	21	15
		5	15	2.0	68	51	67	51	66	49	63	47
		6	23	4.5	150	115	149	114	147	112	142	107
		7	30	8.0	267	203	266	202	262	199	256	194
		8	35	12.2	407	309	405	308	402	305	394	299
		9	36	15.8	529	403	528	402	524	399	517	393
		10	32	17.4	581	442	580	441	576	439	569	434
		11	23	15.1	506	385	505	384	502	382	497	379
		12	14	11.0	366	279	365	279	364	278	361	276
		13	7	6.4	215	163	215	163	214	163	212	162
		14	3	3.2	107	82	107	82	107	82	106	81
		15	1	1.2	40	31	40	31	40	31	40	31
			232	97.7	3268	2487	3251	2475	3227	2456	3178	2418
			MEAN DIA. 8.8 INCHES. WEIBULL PARAMETERS A= .0. B= 9.33. C= 3.88									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
35	77	2	1	.0	1	1						
		3	2	.1	3	2						
		4	5	.4	16	12	16	12	16	12	15	11
		5	9	1.2	44	35	44	35	43	34	42	32
		6	14	2.7	99	77	99	77	98	76	96	74
		7	19	5.1	182	143	182	143	180	141	178	139
		8	24	8.4	302	236	301	235	299	234	295	231
		9	27	11.9	429	335	428	334	426	332	422	329
		10	28	15.2	549	430	548	429	546	427	542	424
		11	26	17.1	617	482	616	481	614	480	611	477
		12	22	17.3	622	486	621	485	619	484	616	482
		13	16	14.7	530	414	530	414	528	413	526	412
		14	10	10.7	385	300	385	300	384	300	382	299
		15	6	7.4	264	207	264	207	264	207	263	206
		16	3	4.2	150	117	150	117	150	117	150	118
		17	1	1.6	57	45	57	45	57	45	56	44
			213	118.0	4250	3322	4241	3314	4224	3302	4194	3278
			MEAN DIA. 10.1 INCHES. WEIBULL PARAMETERS A= .0. B= 10.70. C= 3.74									
40	84	2	1	.0	1	1						
		3	2	.1	3	2						
		4	3	.3	10	8	10	8	10	8	9	7
		5	6	.8	32	25	32	25	31	24	29	23
		6	9	1.8	68	54	68	54	66	53	64	51
		7	12	3.2	122	97	122	97	120	96	118	94
		8	15	5.2	199	159	199	158	197	157	195	155
		9	19	8.4	319	254	318	253	316	252	313	249
		10	21	11.4	435	346	434	345	433	344	430	342
		11	19	12.5	476	380	475	380	474	378	471	376
		12	22	17.3	656	523	655	522	654	521	651	518
		13	20	18.4	700	558	699	558	697	557	694	555
		14	16	17.1	650	518	650	518	648	517	646	515
		15	13	15.9	606	483	606	483	605	482	603	481
		16	9	12.6	477	380	477	380	476	380	475	379
		17	6	9.5	359	286	359	286	358	286	357	286
		18	3	5.3	202	160	202	160	202	160	201	161
		19	2	3.9	150	119	150	119	150	119	149	120
		20	1	2.2	83	66	83	66	83	66	82	66
			199	146.0	5548	4419	5539	4412	5520	4400	5487	4378
			MEAN DIA. 11.6 INCHES. WEIBULL PARAMETERS A= .0. B= 12.29. C= 3.55									

SI 60

400 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
15	35	1	20	.1	0	0						
		2	52	1.1	0	0						
		3	80	3.9	14	0						
		4	88	7.6	115	57	110	53	99	44	77	27
		5	75	10.1	209	129	203	125	190	116	163	97
		6	48	9.3	220	146	215	143	204	136	181	122
		7	24	6.3	161	110	158	108	150	104	135	96
		8	9	3.1	83	58	81	57	78	55	70	51
		9	3	1.3	36	25	35	25	34	24	31	23
		10	1	.5	15	10	15	10	14	10	13	10
			400	43.4	853	535	817	521	769	489	670	426
			MEAN DIA. 4.5 INCHES. WEIBULL PARAMETERS A= .0, B= 4.64, C= 2.61									
20	49	1	2	.0	0	0						
		2	11	.2	0	0						
		3	28	1.4	1	0						
		4	50	4.4	85	29	61	25	52	17	34	0
		5	88	9.3	195	123	193	118	180	106	153	83
		6	77	15.1	378	256	371	251	354	238	320	213
		7	64	17.1	465	327	458	323	442	312	410	292
		8	42	14.7	419	301	414	298	402	292	378	280
		9	21	9.3	274	193	271	190	264	185	251	180
		10	7	3.8	115	85	114	85	112	84	107	82
		11	2	1.3	40	30	40	30	39	30	38	29
			372	76.6	1956	1350	1922	1328	1845	1274	1691	1169
			MEAN DIA. 6.1 INCHES. WEIBULL PARAMETERS A= .0, B= 6.51, C= 3.42									
25	60	1	1	.0	0	0						
		2	4	.1	0	0						
		3	12	.6	7	2						
		4	24	2.1	46	20	44	26	40	22	31	14
		5	39	5.3	138	95	135	92	128	86	114	74
		6	53	10.4	293	209	289	206	279	197	260	181
		7	59	15.8	466	339	461	335	450	326	429	309
		8	55	19.2	585	430	580	427	569	419	548	404
		9	42	18.5	576	428	572	426	564	420	547	409
		10	29	13.6	430	320	428	319	422	315	411	309
		11	11	7.3	231	173	230	172	227	171	222	169
		12	4	3.1	101	76	101	76	100	76	98	75
		13	1	.9	30	22	30	22	29	22	28	22
			330	96.9	2903	2122	2870	2101	2808	2054	2688	1966
			MEAN DIA. 7.3 INCHES. WEIBULL PARAMETERS A= .0, B= 7.78, C= 3.69									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
30	69	2	2	.0	1	1						
		3	6	.3	10	7						
		4	13	1.1	36	28	35	27	34	25	31	22
		5	22	3.0	98	74	97	73	94	71	88	66
		6	32	6.2	207	156	205	155	201	151	192	145
		7	41	10.9	361	274	359	272	353	268	343	259
		8	45	15.6	519	394	517	392	511	387	499	377
		9	45	19.7	658	499	655	497	649	492	636	483
		10	37	20.0	668	507	666	506	660	502	650	495
		11	26	17.0	568	431	566	430	563	428	556	424
		12	15	11.7	390	297	389	296	387	295	383	292
		13	7	6.4	214	162	214	162	212	162	210	161
		14	3	3.2	106	81	106	81	106	81	105	80
		15	1	1.2	40	31	40	31	40	31	40	30
			295	116.4	3876	2942	3849	2922	3810	2893	3733	2834
			MEAN DIA. 8.5 INCHES. WEIBULL PARAMETERS A= .0. B= 9.03. C= 3.72									
35	77	2	1	.0	1	1						
		3	4	.2	7	6						
		4	7	.6	22	17	22	17	21	16	19	15
		5	13	1.8	64	50	63	49	61	48	58	45
		6	19	3.7	134	104	133	103	131	101	126	97
		7	26	6.9	248	194	247	193	244	190	239	185
		8	31	10.8	387	303	386	302	382	299	376	293
		9	35	15.4	553	431	551	430	548	427	540	421
		10	35	19.0	683	533	681	532	677	529	669	523
		11	31	20.4	731	571	730	570	726	568	720	563
		12	25	19.6	702	548	701	547	698	545	693	541
		13	18	18.5	594	463	593	462	591	461	587	459
		14	11	11.7	421	328	420	328	419	327	417	326
		15	6	7.3	263	205	263	205	262	205	261	204
		16	3	4.2	149	116	149	116	149	116	149	116
		17	1	1.6	56	44	56	44	56	44	56	44
			266	139.8	5015	3914	4995	3898	4965	3876	4910	3832
			MEAN DIA. 9.8 INCHES. WEIBULL PARAMETERS A= .0. B= 10.41. C= 3.62									
40	84	2	1	.0	1	1						
		3	2	.1	3	2						
		4	5	.4	17	13	17	13	16	12	14	11
		5	8	1.1	42	32	41	32	40	31	37	29
		6	12	2.4	90	71	89	70	87	68	83	65
		7	16	4.3	162	130	161	129	159	126	154	121
		8	20	7.0	266	211	265	210	261	207	255	201
		9	24	10.8	403	321	401	320	398	316	390	310
		10	26	14.2	538	429	536	428	533	424	525	417
		11	26	17.2	652	519	650	518	647	514	639	508
		12	26	20.5	776	617	774	616	770	613	762	607
		13	23	21.3	805	641	804	640	800	638	793	633
		14	19	20.4	771	614	770	613	767	611	762	607
		15	14	17.2	652	520	651	519	649	518	646	515
		16	10	14.0	530	421	529	421	528	421	525	420
		17	6	9.5	359	286	359	286	358	285	356	284
		18	3	5.3	201	160	201	160	200	160	199	160
		19	2	3.9	150	119	150	119	150	119	149	119
		20	1	2.2	83	66	83	66	83	66	82	65
			244	171.7	6501	5173	6481	5160	6446	5129	6371	5072
			MEAN DIA. 11.4 INCHES. WEIBULL PARAMETERS A= .0. B= 12.03. C= 3.46									

SI 60

500 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
15	35	1	37	.2	0	0						
		2	79	1.7	0	0						
		3	108	5.3	34	0						
		4	108	9.4	156	84	150	80	137	69	110	49
		5	83	11.2	242	154	236	150	221	139	193	119
		6	50	9.8	235	159	230	155	218	147	195	131
		7	23	6.1	156	109	153	107	146	102	133	93
		8	9	3.1	83	58	82	57	78	55	71	51
		9	2	.9	24	17	24	17	23	16	21	15
		10	1	.5	15	10	15	10	14	10	13	10
			500	48.2	945	591	890	576	837	538	736	468
			MEAN DIA. 4.2 INCHES, WEIBULL PARAMETERS A= .0, B= 4.34, C= 2.42									
20	49	1	5	.0	0	0						
		2	19	.4	0	0						
		3	42	2.1	6	0						
		4	70	6.1	99	48	93	43	80	31	55	7
		5	89	12.1	269	170	261	164	243	148	207	118
		6	89	17.5	445	304	436	298	415	283	375	254
		7	72	19.2	528	374	520	369	501	357	465	334
		8	44	15.4	442	318	436	315	423	308	397	295
		9	21	9.3	275	201	272	200	265	196	251	190
		10	7	3.8	115	85	114	84	111	83	106	81
		11	2	1.3	40	30	40	30	39	30	37	29
			460	87.2	2219	1530	2172	1503	2077	1436	1893	1308
			MEAN DIA. 5.9 INCHES, WEIBULL PARAMETERS A= .0, B= 6.23, C= 3.24									
25	60	1	1	.0	0	0						
		2	7	.2	0	0						
		3	18	.9	12	4						
		4	34	3.0	65	41	62	38	57	32	45	20
		5	52	7.1	185	128	181	124	171	115	152	97
		6	67	13.1	372	265	366	260	353	249	328	228
		7	72	19.2	570	415	564	410	548	399	519	376
		8	63	21.9	670	494	664	490	651	480	624	462
		9	45	19.8	618	459	614	456	603	450	583	437
		10	26	14.1	446	333	443	332	437	328	425	321
		11	11	7.2	231	173	230	172	227	171	221	168
		12	4	3.1	101	75	101	75	99	75	97	74
		13	1	.9	30	22	30	22	29	22	28	22
			401	110.5	3300	2409	3255	2379	3175	2321	3022	2205
			MEAN DIA. 7.1 INCHES, WEIBULL PARAMETERS A= .0, B= 7.53, C= 3.54									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
30	69	1	1	.0	0	0						
		2	3	.1	2	1						
		3	9	.4	14	10						
		4	17	1.5	48	36	47	35	45	33	40	28
		5	29	4.0	130	98	128	96	124	92	115	84
		6	41	8.1	266	201	263	199	257	193	244	182
		7	51	13.6	452	342	449	339	441	332	425	319
		8	55	19.2	637	484	633	481	625	474	608	460
		9	51	22.6	750	569	746	566	738	560	721	548
		10	41	22.4	745	566	742	564	735	559	721	550
		11	28	18.5	616	468	614	467	609	464	600	458
		12	15	11.8	393	298	392	297	389	296	384	293
		13	7	6.5	215	164	214	164	213	163	211	161
		14	2	2.1	71	55	71	55	71	55	70	54
		15	1	1.2	41	31	41	31	41	31	41	31
			351	131.9	4380	3323	4340	3294	4288	3252	4180	3168
			MEAN DIA. 8.3 INCHES, WEIBULL PARAMETERS A= .0, B= 8.80, C= 3.60									
35	77	2	2	.0	1	1						
		3	5	.2	8	7						
		4	10	.9	31	24	31	23	29	22	27	19
		5	16	2.2	79	61	78	60	75	58	70	53
		6	24	4.7	169	132	168	131	164	127	157	120
		7	32	8.6	307	238	305	236	300	232	290	224
		8	38	13.3	474	370	472	368	466	363	456	353
		9	42	18.6	664	517	661	515	655	510	643	500
		10	40	21.8	781	608	779	606	773	602	761	593
		11	35	23.1	826	645	824	643	818	640	806	632
		12	28	22.0	787	614	785	613	781	610	772	604
		13	19	17.5	627	489	626	488	623	486	617	483
		14	11	11.8	421	328	420	328	418	327	415	325
		15	6	7.4	263	205	263	205	262	205	260	205
		16	3	4.2	150	116	150	116	150	116	149	116
		17	1	1.6	56	44	56	44	56	44	56	44
			312	157.8	5644	4399	5618	4376	5570	4342	5481	4271
			MEAN DIA. 9.6 INCHES, WEIBULL PARAMETERS A= .0, B= 10.21, C= 3.53									
40	84	2	1	.0	1	1						
		3	3	.1	6	5						
		4	6	.5	20	15	20	15	18	13	16	11
		5	10	1.4	51	40	50	39	48	37	44	34
		6	14	2.7	104	82	103	81	99	78	93	72
		7	19	5.1	191	152	189	150	186	148	178	138
		8	24	8.4	316	251	314	249	308	244	297	235
		9	28	12.3	466	371	463	369	457	363	445	352
		10	31	16.9	637	507	634	504	627	499	614	487
		11	32	21.1	796	633	793	631	786	625	773	614
		12	29	22.7	858	682	856	680	851	675	838	666
		13	26	23.9	903	718	901	716	895	713	885	705
		14	21	22.4	846	673	844	672	840	669	831	663
		15	15	18.4	694	551	693	550	689	548	683	545
		16	10	13.9	526	418	525	418	523	417	519	415
		17	6	9.4	357	283	356	283	355	283	352	282
		18	4	7.1	266	212	266	212	265	212	264	211
		19	2	3.9	149	118	149	118	148	118	147	118
		20	1	2.2	83	65	83	65	83	65	82	65
			282	192.5	7270	5777	7239	5752	7177	5705	7061	5613
			MEAN DIA. 11.2 INCHES, WEIBULL PARAMETERS A= .0, B= 11.84, C= 3.39									

SI 60

600 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	------		-------- *Ft 3* --------					
15	35	1	59	.3	0	0						
		2	109	2.4	0	0						
		3	136	6.7	57	7						
		4	124	10.8	192	109	186	104	171	92	142	80
		5	88	12.0	264	171	258	166	243	155	215	134
		6	50	9.8	239	162	234	159	223	151	202	135
		7	23	6.1	158	110	155	108	149	104	136	95
		8	8	2.8	75	53	74	52	70	50	64	45
		9	2	.9	24	17	24	17	23	16	21	15
		10	1	.5	15	11	15	11	14	10	13	9
			600	52.3	1024	640	946	617	893	578	793	502
			MEAN DIA. 4.0 INCHES. WEIBULL PARAMETERS A= .0. B= 4.09. C= 2.26									
20	49	1	7	.0	0	0						
		2	27	.6	0	0						
		3	50	2.8	14	0						
		4	90	7.8	133	80	126	63	109	47	77	17
		5	108	14.6	334	215	324	207	302	188	258	152
		6	103	20.1	520	358	510	351	485	333	437	298
		7	78	20.7	574	408	565	403	544	380	503	364
		8	46	16.0	462	334	456	331	441	323	413	308
		9	20	8.8	262	191	259	190	252	186	238	180
		10	7	3.8	115	85	114	84	111	83	106	81
		11	2	1.3	41	30	41	30	39	30	37	29
			546	96.6	2455	1690	2395	1659	2283	1579	2069	1429
			MEAN DIA. 5.7 INCHES. WEIBULL PARAMETERS A= .0. B= 6.01. C= 3.11									
25	60	1	2	.0	0	0						
		2	10	.2	0	0						
		3	24	1.2	17	7						
		4	44	3.8	86	55	83	52	74	43	58	27
		5	66	9.0	238	165	232	160	219	148	193	124
		6	81	15.9	454	325	447	319	430	305	397	277
		7	82	21.9	654	478	646	472	629	458	593	430
		8	70	24.4	749	563	742	548	726	537	694	515
		9	48	21.2	663	492	658	489	646	482	622	468
		10	26	14.2	449	335	446	333	439	330	426	322
		11	11	7.3	232	174	231	173	227	172	221	169
		12	3	2.4	75	57	76	57	75	57	73	56
		13	1	.9	30	22	30	22	29	22	28	23
			468	122.5	3648	2663	3591	2625	3493	2554	3305	2411
			MEAN DIA. 6.9 INCHES. WEIBULL PARAMETERS A= .0. B= 7.34. C= 3.43									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
30	69	1	1	.0	0	0						
		2	4	.1	2	2						
		3	11	.5	17	12						
		4	22	1.9	61	46	59	44	56	41	48	34
		5	36	4.9	159	120	156	118	150	112	138	100
		6	50	9.8	322	243	318	240	309	232	292	216
		7	60	16.0	529	400	524	396	513	387	492	369
		8	62	21.8	715	542	710	538	699	529	677	512
		9	57	25.1	834	632	829	629	818	621	797	605
		10	44	23.9	796	604	792	601	784	596	767	584
		11	29	19.1	636	482	634	481	628	477	616	471
		12	16	12.5	418	317	417	316	413	314	407	311
		13	7	6.4	215	163	214	163	213	162	210	161
		14	2	2.1	71	54	71	54	71	54	70	53
		15	1	1.2	41	31	41	31	41	31	40	31
			402	145.3	4816	3648	4765	3611	4695	3556	4554	3447
			MEAN DIA. 8.1 INCHES. WEIBULL PARAMETERS A= .0. B= 8.63. C= 3.52									
35	77	2	2	.0	1	1						
		3	6	.3	11	8						
		4	12	1.0	37	29	36	28	34	26	29	21
		5	20	2.7	97	76	95	74	92	71	84	63
		6	29	5.7	202	157	200	155	194	150	184	141
		7	37	9.8	352	274	349	271	342	265	328	253
		8	44	15.3	546	425	543	422	535	415	519	401
		9	46	20.2	722	563	719	560	710	552	694	538
		10	45	24.4	872	679	868	676	860	670	844	657
		11	39	25.6	915	712	912	710	904	704	889	694
		12	30	23.5	838	652	835	650	830	647	818	640
		13	20	18.4	655	510	653	509	650	507	642	502
		14	12	12.8	456	355	455	355	453	353	448	351
		15	6	7.3	261	203	261	203	260	203	258	202
		16	3	4.2	149	115	149	115	148	115	147	115
		17	1	1.6	56	44	56	44	56	44	56	43
			352	172.8	6170	4803	6131	4772	6068	4722	5940	4621
			MEAN DIA. 9.5 INCHES. WEIBULL PARAMETERS A= .0. B= 10.05. C= 3.47									
40	84	2	1	.0	1	1						
		3	4	.2	8	6						
		4	7	.6	23	18	22	17	20	15	17	11
		5	12	1.6	61	49	60	48	56	44	50	37
		6	17	3.3	126	100	124	98	119	93	109	84
		7	22	5.9	221	176	219	173	213	167	201	155
		8	28	9.7	368	292	365	289	357	281	341	267
		9	32	14.1	532	422	528	419	519	411	502	396
		10	34	18.5	697	554	693	551	684	543	665	527
		11	33	21.7	819	650	815	647	806	639	787	625
		12	32	25.1	945	751	941	748	932	741	914	727
		13	28	25.7	970	771	967	769	959	763	945	753
		14	22	23.5	884	702	881	700	875	697	863	689
		15	16	19.6	738	586	736	585	732	583	724	578
		16	11	15.3	577	459	576	458	573	456	568	453
		17	7	11.0	415	330	414	330	412	329	408	327
		18	4	7.0	265	211	265	211	264	211	262	210
		19	2	3.9	148	117	148	117	147	117	146	117
		20	1	2.2	82	65	82	65	82	65	81	65
			313	209.0	7880	6260	7836	6225	7750	6155	7583	6021
			MEAN DIA. 11.1 INCHES. WEIBULL PARAMETERS A= .0. B= 11.71. C= 3.35									

SI 70

100 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
15	41	2	1	.0	0	0						
		3	3	.1	0	0						
		4	8	.7	3	0	3	0	2	0	0	0
		5	15	2.0	30	12	29	11	26	9	21	5
		6	21	4.1	83	48	81	47	78	44	71	38
		7	23	6.2	145	93	143	92	139	89	131	83
		8	17	5.9	154	103	152	102	149	100	141	96
		9	9	4.0	109	76	108	76	106	74	102	72
		10	3	1.6	46	32	46	32	45	32	44	32
			100	24.8	570	364	562	360	545	348	510	326
			MEAN DIA. 6.7 INCHES. WEIBULL PARAMETERS A= .0, B= 7.16, C= 4.31									
20	57	3	1	.0	0	0						
		4	3	.3	5	2	5	2	5	2	4	1
		5	5	.8	19	12	19	12	18	11	17	10
		6	11	2.2	58	39	57	39	56	37	53	35
		7	16	4.3	123	85	122	84	120	82	117	79
		8	19	6.7	199	140	198	139	196	137	191	133
		9	19	8.4	259	184	258	183	256	181	251	178
		10	13	7.1	223	160	222	159	220	158	217	155
		11	6	4.0	126	91	126	91	125	90	124	89
		12	2	1.6	50	37	50	37	50	37	49	36
			96	35.3	1062	750	1057	746	1046	735	1023	716
			MEAN DIA. 8.2 INCHES. WEIBULL PARAMETERS A= .0, B= 8.72, C= 4.89									
25	70	4	1	.1	3	2	3	2	3	2	3	2
		5	3	.4	14	10	14	10	14	10	14	10
		6	6	1.2	41	31	41	31	41	31	40	30
		7	10	2.6	93	70	93	70	93	70	92	69
		8	14	4.8	169	127	169	127	169	126	168	125
		9	13	7.8	276	206	276	206	275	206	274	205
		10	16	8.6	303	226	303	226	303	226	302	225
		11	12	7.8	275	205	275	205	275	205	274	205
		12	7	5.4	191	143	191	143	191	143	190	142
		13	3	2.7	95	72	95	72	95	72	96	71
		14	1	1.1	37	28	37	28	37	28	37	28
			91	42.4	1497	1120	1497	1120	1496	1119	1490	1112
			MEAN DIA. 9.2 INCHES. WEIBULL PARAMETERS A= .0, B= 9.82, C= 4.91									
30	81	4	1	.1	4	2	4	2	4	2	4	2
		5	2	.3	11	9	11	9	11	9	11	9
		6	4	.8	32	24	32	24	32	24	32	24
		7	6	1.8	64	50	64	50	64	50	64	50
		8	9	3.2	125	98	125	98	125	98	125	97
		9	12	5.4	211	164	211	164	211	164	211	164
		10	16	8.8	348	269	348	269	348	269	347	269
		11	13	8.7	342	265	342	265	342	265	342	265
		12	11	8.8	344	267	344	267	344	267	344	267
		13	7	6.5	257	199	257	199	257	199	257	200
		14	4	4.3	170	132	170	132	170	132	170	132
		15	1	1.2	48	38	48	38	48	38	48	38
			86	49.7	1956	1517	1956	1517	1956	1517	1955	1517
			MEAN DIA. 10.3 INCHES. WEIBULL PARAMETERS A= .0, B= 10.94, C= 4.71									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
35	90	4	1	.1	4	3	4	3	4	3	4	3
		5	1	.1	6	4	6	4	6	4	5	4
		6	3	.6	25	20	25	20	25	20	24	19
		7	4	1.1	46	37	46	37	45	36	44	35
		8	6	2.1	90	72	90	72	90	72	89	71
		9	8	3.6	152	120	152	120	151	120	150	120
		10	10	5.5	233	187	233	187	232	186	231	185
		11	11	7.3	311	248	311	248	310	247	308	246
		12	11	8.7	370	295	369	295	368	295	366	294
		13	10	9.3	394	314	394	314	393	314	392	313
		14	8	8.7	366	292	366	292	365	292	364	291
		15	5	6.2	262	210	262	210	262	210	261	210
		16	3	4.2	179	144	179	144	179	144	179	143
		17	1	1.6	67	54	67	54	67	54	67	53
			82	59.2	2505	2000	2504	2000	2497	1997	2484	1987
		MEAN DIA. 11.5 INCHES. WEIBULL PARAMETERS A .0. B= 12.23. C= 4.41										
40	97	4	1	.1	4	3	4	3	4	3	3	3
		5	1	.1	7	4	7	4	6	4	5	4
		6	2	.4	17	15	17	15	17	14	16	13
		7	3	.8	36	29	36	29	36	29	35	28
		8	4	1.4	63	51	63	51	62	50	60	48
		9	5	2.2	100	81	100	81	98	80	96	78
		10	7	3.8	172	140	171	140	170	138	167	136
		11	8	5.3	237	193	237	193	235	191	233	189
		12	9	7.1	319	259	318	258	316	257	313	254
		13	8	7.4	332	270	331	270	330	269	327	267
		14	8	8.6	385	314	384	314	383	312	380	310
		15	7	8.7	387	316	386	316	385	315	382	313
		16	6	8.4	377	307	377	307	375	306	373	305
		17	4	6.4	284	231	284	231	283	231	282	230
		18	3	5.3	239	195	239	195	238	195	237	194
		19	2	4.0	177	144	177	144	177	144	176	144
		20	1	2.2	99	80	99	80	99	80	98	79
			79	72.4	3235	2632	3230	2631	3214	2618	3183	2595
		MEAN DIA. 13.0 INCHES. WEIBULL PARAMETERS A= .0. B= 13.77. C= 4.07										

SI 70

200 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
15	41	1	1	.0	0	0						
		2	6	.1	0	0						
		3	16	.8	0	0						
		4	29	2.5	25	4	23	4	20	2	12	0
		5	41	5.6	101	54	99	52	93	47	82	37
		6	42	8.2	187	117	184	115	177	109	163	99
		7	35	9.3	237	158	234	156	228	152	215	143
		8	20	7.0	189	131	187	130	183	127	175	121
		9	8	3.5	100	70	99	70	97	68	93	66
		10	2	1.1	32	22	32	22	31	22	30	21
			200	38.2	871	556	858	549	829	527	770	487
			MEAN DIA. 5.9 INCHES, WEIBULL PARAMETERS A= .0, B= 6.28, C= 3.65									
20	57	2	1	.0	0	0						
		3	4	.2	2	0						
		4	11	1.0	19	11	18	10	17	9	14	6
		5	20	2.7	67	43	66	42	64	40	59	36
		6	31	6.1	167	113	165	112	162	108	154	102
		7	39	10.4	303	211	301	209	296	206	287	198
		8	37	12.9	390	275	388	274	383	270	373	263
		9	27	11.9	369	263	368	262	364	259	357	254
		10	14	7.6	240	173	239	172	237	171	234	168
		11	5	3.3	105	76	105	76	104	76	103	75
		12	1	.8	25	19	25	19	25	19	25	18
			190	56.8	1687	1184	1675	1176	1652	1158	1606	1120
			MEAN DIA. 7.4 INCHES, WEIBULL PARAMETERS A= .0, B= 7.87, C= 4.27									
25	70	2	1	.0	1	1						
		3	2	.1	3	2						
		4	5	.4	16	11	16	11	16	11	15	10
		5	11	1.5	53	39	53	39	52	38	51	37
		6	18	3.5	123	92	123	92	122	91	121	89
		7	26	7.0	243	181	242	181	241	179	239	177
		8	33	11.5	403	300	402	299	401	298	398	295
		9	31	13.7	479	357	478	356	477	355	475	352
		10	25	13.7	477	355	477	354	476	353	474	351
		11	15	9.9	346	257	346	257	345	257	344	256
		12	7	5.5	192	143	192	143	192	143	191	142
		13	2	1.8	64	48	64	48	64	48	64	48
			176	68.7	2400	1786	2393	1780	2386	1773	2372	1757
			MEAN DIA. 8.5 INCHES, WEIBULL PARAMETERS A= .0, B= 8.99, C= 4.38									
30	81	3	1	.0	2	1						
		4	3	.3	10	8	10	8	10	8	10	8
		5	7	1.0	37	29	37	29	37	29	37	29
		6	11	2.2	84	65	84	65	84	65	84	64
		7	17	4.5	177	137	177	137	177	137	176	137
		8	22	7.7	298	231	298	231	298	231	298	231
		9	25	11.0	429	332	429	332	429	332	429	331
		10	26	14.2	550	424	550	424	550	424	550	425
		11	22	14.5	563	435	563	435	563	435	564	435
		12	15	11.8	457	353	457	353	457	353	457	353
		13	8	8.3	322	248	322	248	322	248	322	249
		14	4	4.3	165	128	165	128	165	128	166	128
		15	1	1.2	47	37	47	37	47	37	47	37
			163	80.9	3141	2428	3139	2427	3139	2427	3140	2427
			MEAN DIA. 9.5 INCHES, WEIBULL PARAMETERS A= .0, B= 10.14, C= 4.27									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
35	90	3	1	.0	3	1						
		4	2	.2	8	5	8	5	8	5	8	5
		5	4	.6	23	19	23	19	23	19	23	19
		6	7	1.4	58	47	58	47	58	47	58	47
		7	11	3.0	124	98	124	98	124	98	124	99
		8	14	4.9	206	164	206	164	206	164	206	164
		9	18	8.0	336	268	336	268	336	268	335	267
		10	20	11.0	460	366	460	366	460	366	460	365
		11	22	14.6	613	487	613	487	613	487	612	486
		12	19	15.0	630	500	630	500	630	500	629	500
		13	15	13.9	584	463	584	463	584	463	583	464
		14	10	10.8	452	358	452	358	451	358	450	359
		15	5	7.4	310	246	310	246	310	246	310	247
		16	3	4.2	176	140	176	140	176	140	176	140
		17	1	1.6	66	53	66	53	66	53	66	53
			153	96.7	4049	3215	4046	3214	4045	3214	4040	3215
			MEAN DIA. 10.8 INCHES. WEIBULL PARAMETERS A= .0. B= 11.44. C= 4.04									
40	97	3	1	.0	3	1						
		4	2	.2	8	6	8	6	8	6	8	6
		5	3	.4	19	14	19	14	19	14	19	14
		6	5	1.0	44	35	44	35	44	36	44	35
		7	7	1.9	84	68	84	68	84	68	84	68
		8	9	3.2	141	114	141	114	140	114	139	113
		9	12	5.4	237	193	237	193	237	192	236	191
		10	14	7.7	342	276	342	276	341	276	340	276
		11	15	10.0	443	359	443	359	443	359	442	358
		12	16	12.7	562	456	562	456	561	456	560	455
		13	15	14.0	619	501	619	501	618	501	617	501
		14	14	15.2	670	543	670	543	670	543	669	543
		15	11	13.7	603	490	603	490	603	490	602	489
		16	8	11.3	500	405	500	405	500	405	499	404
		17	6	9.6	423	343	423	343	423	343	422	344
		18	3	5.4	237	193	237	193	237	193	237	192
		19	2	4.0	176	143	176	143	176	143	176	143
		20	1	2.2	98	79	98	79	98	79	97	79
			144	117.9	5209	4220	5206	4219	5202	4218	5191	4211
			MEAN DIA. 12.3 INCHES. WEIBULL PARAMETERS A= .0. B= 13.00. C= 3.79									

SI 70

300 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft* 2	*Ft* 3							
15	41	1	4	.0	0	0						
		2	15	.3	0	0						
		3	34	1.7	0	0						
		4	55	4.8	63	23	60	21	54	15	41	3
		5	66	9.0	182	105	178	102	169	95	151	81
		6	59	11.6	280	179	276	176	265	170	245	157
		7	40	10.7	283	190	280	188	272	183	256	174
		8	19	6.6	185	127	183	126	179	124	170	120
		9	7	3.1	90	63	89	63	87	62	83	60
		10	1	.5	17	11	17	11	16	11	15	11
			300	48.5	1100	808	1083	807	1042	660	961	806
			MEAN DIA. 5.4 INCHES. WEIBULL PARAMETERS A= .0, B= 5.75, C= 3.28									
20	57	1	1	.0	0	0						
		2	3	.1	0	0						
		3	11	.5	6	1						
		4	23	2.0	42	24	41	23	38	20	32	15
		5	39	5.3	135	89	133	87	128	82	118	73
		6	52	10.2	285	196	282	193	275	187	262	175
		7	56	14.9	442	309	439	306	431	300	415	288
		8	48	16.7	512	362	509	360	501	355	487	345
		9	30	13.2	414	296	412	295	407	291	397	285
		10	14	7.6	242	174	241	173	239	172	234	169
		11	4	2.6	84	61	84	61	83	61	82	60
		12	1	.8	25	19	25	19	25	19	25	18
			282	74.0	2187	1531	2166	1517	2127	1487	2052	1428
			MEAN DIA. 8.9 INCHES. WEIBULL PARAMETERS A= .0, B= 7.37, C= 3.92									
25	70	2	1	.0	1	1						
		3	5	.2	8	5						
		4	11	1.0	33	25	33	25	32	24	31	23
		5	21	2.9	100	74	99	73	98	72	95	69
		6	33	6.5	225	167	224	166	222	164	217	160
		7	42	11.2	390	289	389	288	386	285	380	280
		8	48	16.7	581	431	580	430	577	427	571	422
		9	41	18.1	628	466	627	465	625	463	621	459
		10	29	15.8	548	407	547	406	546	405	543	402
		11	16	10.6	366	272	366	272	365	271	363	269
		12	6	4.7	164	122	164	122	164	121	163	120
		13	2	1.8	64	47	64	47	64	47	64	47
			255	89.5	3108	2307	3093	2294	3079	2279	3048	2251
			MEAN DIA. 8.0 INCHES. WEIBULL PARAMETERS A= .0, B= 8.52, C= 4.08									
30	81	2	1	.0	1	1						
		3	3	.1	5	5						
		4	7	.6	24	18	24	18	24	18	23	18
		5	12	1.6	63	49	63	49	63	49	63	49
		6	20	3.9	153	117	153	117	152	117	151	117
		7	27	7.2	279	216	279	216	279	215	279	214
		8	34	11.9	460	355	460	355	460	354	459	353
		9	36	16.0	616	476	616	476	616	475	616	473
		10	34	18.6	719	554	719	554	719	554	718	553
		11	27	17.9	691	533	691	533	691	533	691	532
		12	17	13.4	517	399	517	399	517	399	518	398
		13	5	8.3	322	248	322	248	322	248	322	247
		14	4	4.3	166	128	166	128	166	128	166	127
		15	1	1.2	47	37	47	37	47	37	47	37
			232	105.2	4064	3136	4057	3130	4056	3127	4053	3118
			MEAN DIA. 9.1 INCHES. WEIBULL PARAMETERS A= .0, B= 9.69, C= 4.03									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
35	90	2	1	.0	1	1						
		3	2	.1	4	3						
		4	4	.4	15	12	15	12	15	12	15	12
		5	7	1.0	40	32	40	32	40	32	40	32
		6	12	2.4	99	78	99	78	99	78	98	78
		7	17	4.6	190	150	190	150	190	150	190	150
		8	22	7.7	321	254	321	254	321	254	322	255
		9	26	11.6	480	381	480	381	480	381	481	381
		10	30	16.5	685	543	685	543	685	543	686	543
		11	27	17.9	746	592	746	592	746	592	747	592
		12	24	19.0	789	626	789	626	789	626	790	625
		13	18	16.7	695	551	695	551	695	551	695	551
		14	12	12.9	537	426	537	426	537	426	538	426
		15	7	8.6	360	285	360	285	360	285	360	285
		16	3	4.2	175	138	175	138	175	138	175	138
		17	1	1.6	66	53	66	53	66	53	66	53
			213	125.1	5203	4125	5198	4121	5198	4121	5203	4121
			MEAN DIA. 10.4 INCHES. WEIBULL PARAMETERS A= .0. B= 11.02. C= 3.86									
40	97	3	1	.0	3	1						
		4	3	.3	12	10	12	10	12	10	12	10
		5	5	.7	30	24	30	24	30	24	30	24
		6	8	1.6	69	57	69	57	69	57	69	57
		7	11	3.0	129	105	129	105	129	105	129	105
		8	14	4.9	216	174	216	174	216	174	216	174
		9	18	8.0	352	284	352	284	352	284	351	284
		10	20	11.0	481	389	481	389	481	389	481	389
		11	22	14.6	641	518	641	518	641	518	641	518
		12	23	18.1	797	644	797	644	797	644	798	644
		13	20	18.5	813	656	813	656	813	656	814	657
		14	17	18.3	801	648	801	648	801	648	802	648
		15	14	17.3	758	613	758	613	758	613	759	613
		16	10	14.0	616	498	616	498	616	490	616	498
		17	6	9.5	417	337	417	337	417	337	417	337
		18	4	7.1	311	252	311	252	311	252	311	252
		19	2	4.0	174	140	174	140	174	140	174	140
		20	1	2.2	97	78	97	78	97	78	97	78
			199	152.9	6717	5428	6714	5427	6714	5427	6717	5428
			MEAN DIA. 11.9 INCHES. WEIBULL PARAMETERS A= .0. B= 12.59. C= 3.64									

SI 70

400 trees per acre

Age	Av dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
15	41	1	8	.0	0	0						
		2	29	.6	0	0						
		3	58	2.8	5	0						
		4	81	7.1	108	48	104	45	95	36	76	20
		5	87	11.8	254	153	249	149	237	139	213	121
		6	69	13.5	336	218	331	215	319	207	296	192
		7	42	11.2	302	203	298	201	289	196	272	187
		8	19	6.6	187	128	185	127	180	125	171	120
		9	6	2.6	77	53	76	53	74	52	71	51
		10	1	.5	16	11	16	11	16	11	15	11
			400	56.9	1285	814	1259	801	1210	766	1114	702
			MEAN DIA. 5.1 INCHES. WEIBULL PARAMETERS A= .0. B= 5.38. C= 3.03									
20	57	1	1	.0	0	0						
		2	7	.2	0	0						
		3	19	.9	11	3						
		4	38	3.3	72	42	70	40	64	35	54	26
		5	59	8.0	208	137	205	134	197	127	181	113
		6	73	14.2	405	279	401	275	390	266	369	248
		7	71	18.9	563	396	558	392	547	384	526	367
		8	55	19.1	587	417	583	414	575	408	558	396
		9	31	13.6	428	306	426	305	420	301	410	295
		10	13	7.0	224	160	223	161	221	160	217	157
		11	4	2.6	85	61	85	61	84	60	82	59
		12	1	.8	25	19	25	19	25	19	25	18
			372	88.6	2608	1802	2576	1801	2523	1760	2422	1679
			MEAN DIA. 6.6 INCHES. WEIBULL PARAMETERS A= .0. B= 7.01. C= 3.69									
25	70	2	3	.1	2	2						
		3	8	.4	15	11						
		4	19	1.7	57	43	56	42	55	40	52	37
		5	32	4.4	150	112	149	111	147	108	142	103
		6	47	9.2	318	236	316	235	313	231	306	224
		7	57	15.2	526	390	524	388	519	384	510	375
		8	59	20.6	711	527	709	525	705	521	696	513
		9	48	21.2	732	542	731	541	727	537	720	531
		10	32	17.4	603	446	602	445	600	443	595	439
		11	16	10.5	364	270	364	270	362	269	360	267
		12	5	4.7	163	121	163	121	162	120	161	119
		13	2	1.8	63	47	63	47	63	47	64	47
			330	107.2	3704	2747	3677	2725	3653	2700	3606	2655
			MEAN DIA. 7.7 INCHES. WEIBULL PARAMETERS A= .0. B= 8.20. C= 3.89									
30	81	2	2	.0	1	1						
		3	5	.2	9	7						
		4	10	.9	33	26	33	26	33	26	32	25
		5	18	2.5	95	73	95	73	94	72	93	71
		6	28	5.5	212	163	211	162	210	161	208	159
		7	38	10.2	391	301	391	300	389	299	387	296
		8	45	15.7	604	465	604	464	602	463	600	460
		9	46	20.3	781	602	781	601	780	600	778	597
		10	40	21.8	839	645	839	645	838	644	837	643
		11	30	19.8	762	585	762	585	761	585	760	584
		12	19	14.9	574	442	574	442	574	441	573	440
		13	9	8.3	319	246	319	246	319	246	319	245
		14	4	4.3	164	127	164	127	164	127	165	126
		15	1	1.2	47	36	47	36	47	36	47	37
			295	125.6	4831	3719	4820	3707	4811	3700	4799	3683
			MEAN DIA. 8.8 INCHES. WEIBULL PARAMETERS A= .0. B= 9.38. C= 3.87									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
35	90	2	1	.0	1	1						
		3	3	.1	6	5						
		4	6	.5	22	17	22	17	22	17	21	17
		5	11	1.5	63	50	63	50	63	50	62	49
		6	17	3.4	140	110	140	110	140	110	139	109
		7	23	6.2	257	204	257	204	257	204	257	203
		8	30	10.6	438	347	438	347	438	347	438	346
		9	34	15.2	629	497	629	497	629	497	628	496
		10	37	20.4	844	668	844	668	844	668	844	667
		11	33	22.0	911	720	911	720	911	720	911	720
		12	27	21.4	886	702	886	702	886	702	888	701
		13	20	18.6	771	610	771	610	771	610	772	609
		14	13	14.0	581	460	581	460	581	460	582	459
		15	7	8.7	360	284	360	284	360	284	359	284
		16	3	4.2	175	138	175	138	175	138	175	138
		17	1	1.6	66	53	66	53	66	53	66	53
			266	148.4	6150	4866	6143	4860	6143	4860	6142	4851
			MEAN DIA. 10.1 INCHES. WEIBULL PARAMETERS A= .0. B= 10.73. C= 3.73									
40	97	2	1	.0	1	1						
		3	2	.1	4	3						
		4	4	.4	16	13	16	13	16	13	16	13
		5	7	1.0	42	34	42	34	42	34	42	34
		6	10	2.0	86	69	86	69	86	69	86	69
		7	15	4.0	176	143	176	143	176	142	177	141
		8	19	6.7	293	236	293	236	293	236	292	235
		9	23	10.2	448	362	448	362	448	362	448	361
		10	26	14.3	625	504	625	504	625	504	624	503
		11	26	17.3	757	610	757	610	757	610	756	609
		12	26	20.6	901	726	901	726	901	726	900	725
		13	24	22.3	975	787	975	787	975	787	975	786
		14	20	21.5	942	760	942	760	942	760	942	759
		15	16	19.8	865	698	865	698	865	698	866	698
		16	11	15.5	677	547	677	547	677	547	678	546
		17	7	11.1	486	393	486	393	486	393	487	392
		18	4	7.1	311	251	311	251	311	251	311	252
		19	2	4.0	174	140	174	140	174	140	174	140
		20	1	2.2	97	78	97	78	97	78	97	78
			244	180.0	7876	6355	7871	6351	7871	6350	7871	6341
			MEAN DIA. 11.6 INCHES. WEIBULL PARAMETERS A .0. B= 12.33. C= 3.54									

SI 70

500 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft* 2	*Ft* 3							
[illegible]	[illegible]	1	16	.1	0	0						
		2	47	1.0	0	0						
		3	84	[illegible]	19	0						
		4	107	9.3	156	78	151	74	139	63	115	43
		5	103	[illegible]	315	194	309	189	294	178	266	157
		6	76	14.9	380	290	375	246	361	237	336	219
		7	43	[illegible]	314	213	310	211	301	205	283	194
		8	18	6.3	179	124	177	123	172	120	163	115
		9	5	[illegible]	64	46	64	46	62	45	60	43
		10	1	.5	16	11	16	11	16	11	15	11
			500	64.1	1443	916	1402	900	1345	[illegible]	1238	782
			MEAN DIA. [illegible] 8 INCHES. WEIBULL PARAMETERS A= .0, B= 5.08, C= 2.83									
[illegible]	57	1	2	.0	0	0						
		2	12	.3	0	0						
		3	30	1.5	20	7						
		4	55	4.8	[illegible]	[illegible]	104	[illegible]	96	54	80	40
		5	79	10.8	285	190	280	[illegible]	268	175	245	154
		6	[illegible]	18.0	518	358	512	[illegible]	[illegible]	[illegible]	470	[illegible]
		7	83	22.1	666	469	660	[illegible]	[illegible]	454	621	434
		8	59	20.6	[illegible]	453	[illegible]	[illegible]	[illegible]	443	603	429
		9	32	14.1	446	[illegible]	444	318	[illegible]	315	427	307
		10	[illegible]	6.5	209	151	208	150	206	149	201	146
		[illegible]	3	2.0	[illegible]	46	64	46	63	46	62	45
		[illegible]	[illegible]	[illegible]	25	19	25	19	25	19	25	18
			460	101.5	2976	2078	2929	2048	[illegible]	1996	2734	1891
			MEAN DIA. 6.4 INCHES. WEIBULL PARAMETERS A= .0, B= 6.74, C= 3.51									
[illegible]	70	[illegible]	1	0	0	0						
		2	[illegible]	.1	3	2						
		3	13	.6	22	16						
		4	27	[illegible]	81	60	80	59	77	56	72	51
		5	44	6.0	207	153	205	151	201	147	192	139
		6	61	12.0	[illegible]	305	411	303	405	297	393	286
		7	72	19.2	664	491	661	488	654	481	640	468
		8	68	23.7	818	605	815	603	809	597	797	586
		9	[illegible]	23.9	822	[illegible]	820	606	815	602	806	594
		10	34	18.5	639	473	638	472	635	469	629	464
		11	16	10.6	364	270	363	269	362	268	359	265
		12	6	4.7	163	121	163	121	162	120	161	119
		13	1	.9	32	23	32	23	32	23	32	23
			[illegible]	122.6	4228	3127	4188	3095	[illegible]	3060	4081	2995
			MEAN DIA. 7.5 INCHES. WEIBULL PARAMETERS A= .0, B= 7.95, C= 3.74									
30	81	2	2	.0	1	1						
		3	7	.3	14	11						
		4	14	1.2	47	36	47	36	46	35	45	33
		5	25	3.4	131	101	130	100	129	98	126	95
		6	37	7.3	279	214	278	213	276	211	272	207
		[illegible]	47	12.6	482	370	481	[illegible]	479	[illegible]	475	[illegible]
		[illegible]	55	19.2	737	567	736	566	733	563	728	557
		[illegible]	53	23.4	899	691	898	690	896	688	892	683
		10	45	24.6	942	724	941	723	940	721	937	718
		11	33	21.8	836	642	836	642	835	640	933	638
		[illegible]	19	14.9	572	440	572	440	572	439	572	438
		13	9	8.3	319	245	319	245	319	245	318	244
		14	4	4.3	164	127	164	127	164	127	164	126
		15	1	1.2	47	36	47	36	47	36	47	36
			351	[illegible]	5470	[illegible]	5443	4187	5436	4170	5409	4137
			MEAN DIA. [illegible] INCHES. WEIBULL PARAMETERS A= .0, B= 9.16, C= 3.75									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
35	90	2	1	.0	1	1						
		3	4	.2	9	7						
		4	8	.7	30	23	30	23	29	23	28	22
		5	14	1.9	79	62	79	62	79	62	78	61
		6	21	4.1	171	135	171	135	170	134	169	133
		7	29	7.8	321	254	321	253	320	252	319	250
		8	36	12.6	521	411	521	411	520	410	518	408
		9	40	17.7	733	579	733	578	732	577	730	575
		10	45	24.6	1018	804	1018	803	1017	802	1015	800
		11	37	24.5	1013	800	1013	800	1012	799	1011	797
		12	30	23.6	977	772	977	772	977	771	977	769
		13	22	20.4	841	665	841	665	841	664	841	662
		14	14	15.0	621	491	621	491	621	490	620	489
		15	7	8.6	357	281	357	281	357	281	356	282
		16	3	4.2	173	137	173	137	173	137	174	137
		17	1	1.6	65	52	65	52	65	52	65	52
			312	167.7	6930	5474	6920	5463	6913	5454	6901	5437
			MEAN DIA. 9.9 INCHES. WEIBULL PARAMETERS A= .0. B= 10.53. C= 3.64									
40	97	2	1	.0	1	1						
		3	3	.1	7	6						
		4	5	.4	20	16	20	16	19	15	18	14
		5	9	1.2	54	44	54	44	53	43	52	42
		6	13	2.6	113	90	113	90	112	90	110	89
		7	18	4.9	212	171	212	171	211	170	210	168
		8	23	8.1	355	285	355	285	354	284	352	282
		9	27	12.1	526	424	526	424	525	422	524	420
		10	30	16.5	722	582	722	581	721	580	719	577
		11	31	20.7	903	727	903	727	902	725	900	723
		12	30	23.8	1040	838	1040	838	1039	836	1038	834
		13	27	25.2	1098	886	1098	885	1098	884	1097	882
		14	22	23.8	1038	836	1038	836	1038	835	1037	834
		15	17	21.1	921	741	921	741	921	741	920	740
		16	12	16.9	739	596	739	596	739	595	739	594
		17	7	11.2	487	393	487	393	487	393	487	392
		18	4	7.1	311	251	311	251	311	251	312	250
		19	2	4.0	174	140	174	140	174	140	175	140
		20	1	2.2	97	78	97	78	97	78	96	78
			282	202.0	8818	7105	8810	7096	8801	7082	8786	7059
			MEAN DIA. 11.5 INCHES. WEIBULL PARAMETERS A= .0. B= 12.14. C= 3.48									

SI 70

600 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
15	41	1	26	.1	0	0						
		2	69	1.5	0	0						
		3	112	5.5	38	0						
		4	130	11.4	203	108	197	103	182	90	154	66
		5	117	16.0	368	232	361	226	345	213	314	188
		6	80	15.7	406	271	400	267	387	256	361	236
		7	43	11.5	316	217	312	214	304	208	287	195
		8	17	5.9	170	118	168	117	164	114	155	109
		9	5	2.2	65	46	64	46	63	44	60	42
		10	1	.5	16	11	16	11	16	11	15	11
			600	70.4	1582	1003	1518	984	1461	936	1346	847
			MEAN DIA. 4.6 INCHES. WEIBULL PARAMETERS A= .0, B= 4.84, C= 2.67									
20	57	1	4	.0	0	0						
		2	17	.4	0	0						
		3	42	2.1	30	12						
		4	73	6.3	145	89	140	85	129	74	108	54
		5	99	13.4	360	242	354	236	338	222	309	195
		6	108	21.1	611	423	604	417	586	402	552	374
		7	93	24.7	748	527	741	522	725	510	694	486
		8	62	21.5	669	477	664	474	653	466	632	450
		9	32	14.1	445	319	443	317	437	314	425	306
		10	12	6.5	209	150	208	149	205	148	200	145
		11	3	2.0	64	46	64	46	63	46	61	45
		12	1	.8	26	19	26	19	26	19	25	18
			546	112.9	3307	2304	3244	2265	3162	2201	3006	2073
			MEAN DIA. 6.2 INCHES. WEIBULL PARAMETERS A= .0, B= 6.52, C= 3.37									
25	70	1	1	.0	0	0						
		2	6	.1	4	3						
		3	18	.9	31	22						
		4	35	3.0	105	77	103	75	99	72	91	64
		5	56	7.6	261	193	258	191	252	185	240	173
		6	75	14.7	505	373	501	370	493	362	476	346
		7	84	22.4	770	569	766	565	756	557	738	540
		8	77	26.8	921	681	918	678	910	670	894	656
		9	58	25.5	878	649	876	647	870	641	858	631
		10	35	19.0	655	483	654	482	650	479	643	474
		11	16	10.5	362	268	361	267	360	266	357	263
		12	6	4.7	162	120	162	120	161	119	160	118
		13	1	.9	32	23	32	23	32	23	32	23
			468	136.3	4686	3461	4631	3418	4583	3374	4489	3288
			MEAN DIA. 7.3 INCHES. WEIBULL PARAMETERS A= .0, B= 7.75, C= 3.62									
30	81	1	1	.0	0	0						
		2	3	.1	2	2						
		3	9	.4	17	13						
		4	18	1.6	60	47	59	46	58	44	55	41
		5	31	4.2	163	124	162	123	160	121	155	117
		6	44	8.7	332	254	331	253	327	249	321	243
		7	56	15.0	575	442	574	440	570	436	563	428
		8	63	22.1	845	650	843	648	840	643	832	634
		9	60	26.6	1019	782	1017	780	1014	777	1007	769
		10	49	26.8	1027	789	1026	788	1024	784	1019	778
		11	35	23.2	888	681	887	680	885	679	882	676
		12	20	15.8	604	463	604	463	603	462	602	460
		13	8	8.3	319	245	319	245	318	245	317	244
		14	3	3.2	123	95	123	95	123	95	123	94
		15	1	1.2	47	36	47	36	47	36	47	37
			402	157.4	6021	4623	5992	4597	5969	4571	5923	4521
			MEAN DIA. 8.5 INCHES. WEIBULL PARAMETERS A= .0, B= 8.99, C= 3.66									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft* 2	– – – – – – – – – – – – – – – – *Ft* 3 – – – – – – – – – – – – – – – –							
35	90	2	2	.0	1	1						
		3	5	.2	10	8						
		4	10	.9	35	29	35	29	35	28	35	26
		5	17	2.3	96	75	96	75	95	74	93	73
		6	26	5.1	211	168	211	167	209	165	207	162
		7	34	9.1	377	297	376	296	374	294	371	291
		8	42	14.7	608	479	607	478	605	476	601	472
		9	47	20.9	860	679	859	678	857	676	854	671
		10	46	25.2	1040	821	1039	820	1037	818	1034	813
		11	41	27.2	1122	885	1121	884	1120	882	1118	878
		12	33	26.0	1074	848	1074	847	1073	846	1071	843
		13	23	21.3	879	694	879	694	878	693	877	691
		14	14	15.0	621	490	621	490	620	489	619	487
		15	8	9.9	407	321	407	321	407	321	407	321
		16	3	4.2	173	136	173	136	173	136	174	137
		17	1	1.6	65	52	65	52	65	52	65	52
			352	183.8	7580	5983	7564	5967	7549	5950	7526	5917
			MEAN DIA. 9.8 INCHES. WEIBULL PARAMETERS A= .0. B= 10.37. C= 3.58									
40	97	2	1	.0	1	1						
		3	3	.1	7	6						
		4	6	.5	23	18	23	18	22	18	21	17
		5	10	1.4	60	48	60	48	59	47	57	45
		6	15	3.0	129	104	128	103	127	102	125	100
		7	21	5.6	246	198	245	197	243	195	240	191
		8	26	9.1	398	321	397	320	395	317	392	312
		9	31	13.8	601	484	600	483	598	480	593	474
		10	34	18.7	813	655	812	654	810	651	806	646
		11	35	23.3	1013	816	1012	815	1010	812	1006	806
		12	33	26.1	1137	916	1136	915	1134	912	1131	906
		13	29	26.9	1172	944	1171	943	1170	941	1167	937
		14	24	25.8	1125	906	1125	905	1124	904	1122	901
		15	18	22.2	969	780	969	780	968	779	966	777
		16	12	16.9	735	592	735	592	735	591	734	590
		17	8	12.7	553	445	553	445	553	444	552	443
		18	4	7.1	310	250	310	250	310	250	309	249
		19	2	4.0	173	139	173	139	173	139	172	139
		20	1	2.2	96	77	96	77	96	77	95	77
			313	219.4	9561	7700	9545	7684	9527	7659	9488	7610
			MEAN DIA. 11.3 INCHES. WEIBULL PARAMETERS A= .0. B= 12.01. C= 3.43									

SI 70

700 trees per acre

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
15	41	1	39	.2	0	0						
		2	93	2.0	0	0						
		3	140	6.9	60	4						
		4	153	13.3	251	139	244	133	228	119	196	91
		5	127	17.3	408	260	401	254	384	240	351	213
		6	83	16.3	425	285	419	280	406	270	381	249
		7	42	11.2	310	213	307	210	299	204	283	192
		8	17	5.9	170	119	168	118	164	115	156	109
		9	5	2.2	64	46	64	46	62	44	60	42
		10	1	.5	16	12	16	12	16	12	15	11
			700	76.0	1704	1078	1619	1053	1559	1004	1442	907
			MEAN DIA. 4.5 INCHES. WEIBULL PARAMETERS A= .0, B= 4.63, C= 2.54									
20	57	1	5	.0	0	0						
		2	24	.5	0	0						
		3	55	2.7	41	18						
		4	91	7.9	184	115	178	109	164	96	137	70
		5	119	16.1	438	294	430	287	411	270	373	237
		6	122	23.8	694	482	685	475	664	458	624	424
		7	101	26.9	815	575	807	569	789	556	754	529
		8	65	22.6	704	502	693	498	686	489	662	472
		9	32	14.1	446	321	443	319	437	315	424	307
		10	11	6.0	191	138	190	137	188	136	184	133
		11	3	2.0	64	46	64	46	63	46	62	45
		12	1	.8	26	19	26	19	26	19	25	18
			630	123.3	3603	2510	3522	2453	3428	2385	3245	2235
			MEAN DIA. 6.0 INCHES. WEIBULL PARAMETERS A= .0, B= 6.33, C= 3.25									
25	70	1	2	.0	0	0						
		2	9	.2	7	5						
		3	23	1.1	39	28						
		4	44	3.9	132	98	130	96	124	90	113	79
		5	68	9.3	320	235	316	231	307	223	289	207
		6	90	17.3	595	440	590	436	579	425	557	404
		7	95	25.5	874	646	869	641	858	630	835	609
		8	84	29.4	1010	746	1006	742	995	733	975	715
		9	61	27.0	928	685	925	682	918	676	904	664
		10	35	19.2	658	485	656	484	652	480	644	474
		11	16	10.6	364	269	363	268	361	267	358	264
		12	5	3.9	135	100	135	100	134	100	133	99
		13	1	.9	32	23	32	23	32	23	32	23
			531	148.4	5094	3760	5022	3703	4960	3647	4840	3538
			MEAN DIA. 7.2 INCHES. WEIBULL PARAMETERS A= .0, B= 7.56, C= 3.53									

Age	Av. dom. ht.	D.b.h.	Stems per acre	Basal area	All trees, total stem		4-inch class and greater to o.b. tops of—					
							2 inches		3 inches		4 inches	
					O. b.	I. b.	O. b.	I. b.	O. b.	I. b.	O. b.	I. b.
Yrs	*Ft*	*In*	*No.*	*Ft 2*	*Ft 3*							
30	81	1	1	.0	0	0						
		2	4	.1	3	2						
		3	11	.5	20	18						
		4	22	1.9	74	56	73	55	71	53	66	48
		5	36	4.9	189	145	187	143	184	140	176	132
		6	52	10.3	391	301	389	299	384	294	375	284
		7	64	17.2	656	504	654	502	648	496	638	484
		8	71	24.9	951	730	949	727	943	721	932	709
		9	65	28.8	1101	845	1099	843	1094	838	1085	828
		10	53	29.0	1109	851	1107	849	1104	845	1097	837
		11	36	23.9	911	699	910	698	908	696	904	691
		12	20	15.8	603	462	603	462	601	460	599	458
		13	9	8.3	318	244	318	244	318	244	317	243
		14	3	3.2	123	95	123	95	123	95	122	94
		15	1	1.2	47	36	47	36	47	36	47	37
			448	170.1	6496	4986	6459	4953	6425	4918	6358	4845
			MEAN DIA. 8.3 INCHES, WEIBULL PARAMETERS A= .0, B= 8.85, C= 3.59									
35	90	2	2	.0	1	1						
		3	6	.3	12	9						
		4	12	1.0	43	34	42	34	41	33	39	31
		5	20	2.7	113	89	112	88	110	86	107	83
		6	29	5.7	235	185	234	184	232	182	227	178
		7	39	10.4	431	340	430	339	426	335	420	328
		8	46	16.1	663	522	662	520	659	517	653	510
		9	51	22.6	930	733	929	731	925	728	919	720
		10	50	27.3	1125	888	1124	887	1121	883	1116	876
		11	44	29.1	1197	945	1196	944	1194	941	1191	936
		12	35	27.5	1134	894	1133	893	1132	891	1129	888
		13	24	22.2	912	720	912	719	911	718	909	715
		14	15	16.1	662	522	662	522	661	521	660	519
		15	8	9.8	405	319	405	319	405	319	404	318
		16	3	4.2	172	136	172	136	172	136	173	136
		17	1	1.6	65	52	65	52	65	52	65	51
			385	196.7	8100	6389	8078	6368	8054	6342	8012	6289
			MEAN DIA. 9.7 INCHES, WEIBULL PARAMETERS A= .0, B= 10.26, C= 3.53									
40	97	2	1	.0	1	1						
		3	4	.2	9	7						
		4	7	.6	27	21	26	21	25	20	23	18
		5	11	1.5	66	53	65	52	64	51	61	48
		6	17	3.4	147	118	146	117	144	115	140	110
		7	23	6.2	269	217	268	216	265	213	260	207
		8	29	10.2	442	357	441	356	438	352	432	345
		9	33	14.7	638	513	636	512	633	508	626	501
		10	36	19.8	859	691	858	689	854	686	848	678
		11	38	25.2	1098	883	1096	881	1093	877	1085	869
		12	35	27.7	1203	968	1202	966	1199	963	1193	956
		13	31	28.7	1251	1006	1250	1005	1248	1002	1243	997
		14	25	26.9	1169	942	1169	941	1167	939	1165	934
		15	19	23.5	1020	821	1020	820	1019	819	1017	816
		16	13	18.3	794	639	794	639	794	638	793	636
		17	8	12.7	551	443	551	443	551	443	550	443
		18	4	7.1	309	249	309	249	309	249	309	249
		19	2	4.0	173	139	173	139	173	139	172	138
		20	1	2.2	96	77	96	77	96	77	95	77
			337	232.7	10122	8145	10100	8123	10072	8091	10012	8022
			MEAN DIA. 11.3 INCHES, WEIBULL PARAMETERS A= .0, B= 11.91, C= 3.40									

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1976. Yield tables and stand structure for unthinned longleaf pine plantations in Louisiana and Texas. South. For. Exp. Stn., New Orleans, La. 53 p. (USDA For. Serv. Res. Pap. SO-133)

Detailed tables of trees per acre, basal area, and cubic-foot yields in eight volume categories by 1-inch diameter classes are presented for several combinations of site index, age from planting, and trees per acre at age 15 years.

Additional keywords: Pinus palustris, volume predictions, unthinned plantation yields, volume yields of longleaf pine.

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Bedding Poorly Drained Sites For Planting Loblolly And Slash Pines In Southwest Louisiana

H. J. DERR
AND
W. F. MANN, JR.

Southern Forest Experiment Station

SUMMARY

Height growth of slash and loblolly pine on poorly drained sites was not consistently improved by bedding in six studies in southwest Louisiana. An early response occurred on all but the wettest sites; by age 10 years height differentials were about 2 feet on the better sites. Bedding decreased survival in early studies, but improved equipment now available should circumvent this problem. Bedding also increased fusiform rust infection nominally.

Landowners should be highly selective in choosing sites to bed, restricting treatment to the most adverse soils. Sites should be evaluated after winter rains are well underway, usually in January and early February. As a general rule, treat only those sites where the water table is at or near the surface for several consecutive weeks. Beds should be constructed several months before planting to allow the soil to settle and minimize air pockets that can reduce survival. To facilitate surface runoff, disk perpendicular to the contours. Depressions may require plowing a few outlet ditches.

Bedding Poorly Drained Sites for Planting Loblolly And Slash Pines in Southwest Louisiana

H. J. DERR AND W. F. MANN, JR.

Bedding has evolved as a widespread preplanting site treatment on wet, poorly drained soils in the Southeast over the past decade or two. Slash pine (*Pinus elliottii* var. *elliottii* Engelm.), which is planted on these flatwood soils, grows very slowly without site amelioration, and in severe situations trees never attain merchantable size. Long periods of soil saturation that reduce aeration in the rooting zone are attributed to unfavorable growing conditions.

A number of investigators working on wet sites from Florida to North Carolina have reported large gains in early growth of loblolly (*P. taeda* L.) and slash pine as a result of elevating beds or ridges 5 to 8 inches high with plows or disks (Bethune 1963, Haines and Pritchett 1964, Langdon 1962, Lennartz and McMinn 1973, Malac and Brightwell 1973, Mann and McGilvray 1974, Schultz 1973, Terry and Hughes 1975). Successes in the Southeast on predominantly sandy loams led to studies further west on heavier, siltier soils common in the flatwoods in southwest Louisiana and southeast Texas. The earliest bedding studies on these problem sites have been in progress since 1960 (Derr and Mann 1970, Mann and Derr 1970, McKee and Shoulders 1974, Shoulders 1974). Growth responses observed in six widely separated studies in southwest Louisiana are examined in this paper. Five included two species, slash and loblolly pine; the 3-year-old installation tests slash pine alone.

METHODS

Soils included in the bedding trials are Wrightsville, which is very poorly drained and unproductive without treatment; Caddo, which has poor to good drainage and quality; and Beauregard, which normally does not include excessively wet areas. However, drainage often varies considerably within each soil type. Characteristics of the six studies[1] are outlined in table 1.

[1]Four studies were designed, installed, and measured in early years by Dr. Eugene Shoulders.

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Treatments common to all tests are untreated check, thorough flat disking, and flat disking plus bedding. The method of constructing beds varied as improved implements become available. In the early trials, modified agricultural tools produced beds that were rough, full of air pockets, and usually had a narrow base. Later an implement developed for forest land bedding was used; it has six cutting disks for finer soil pulverization and a shaping roller that compacts the bedded soil (fig. 1). The bed formed is a strip about 8 feet wide with a convex profile that extends about 8 inches above groundline before settling (fig. 2). In all studies, site preparation was completed during the late summer or early fall preceding the planting season to permit the soil to settle.

Slash and loblolly pine seedlings were obtained from State nurseries and were hand planted. First-year survival was satisfactory in five studies, but it was so low in the 1965 study that plots had to be replanted (table 2).

Test plots are about 0.4 acre to accommodate an interior measurement plot of 100 planted trees. Each study was established as a randomized complete block experiment with four replications in five tests and three replications in the sixth.

Figure 1.—*Bedding disk with rolling shaper widely used for modifying poorly drained forest sites.*

Table 1.—*Characteristics of six bedding studies on poorly drained sites in southwest Louisiana*

Study	Dominant soil type	Parish	Date planted	Species	Plot size (acres)	Measurement plot	No. of replications	Method of bedding
1	Beauregard silt loam	Rapides	Feb. 1964	Slash Loblolly	0.41	9 rows x 12 trees	3	Terracing disk
2	Wrightsville-Caddo silt loam	Calcasieu	Mar. 1961	Slash Loblolly	.38	10 rows x 10 trees	4	Rice levee disk
3	Beauregard-Caddo silt loam	Rapides	Feb. 1962	Slash Loblolly	.36	10 rows x 10 trees	4	Bedding disk
4	Wrightsville-Caddo silt loam	Rapides	Feb. 1965	Slash Loblolly	.36	10 rows x 10 trees	4	Bedding disk
5	Caddo silt loam	Allen	Feb. 1971	Slash Loblolly	.40	10 rows x 10 trees	4	Rome bedding disk w/shaper
6	Wrightsville silt loam	Calcasieu	Feb. 1973	Slash	.40	16 rows x 17 trees	4	Rome bedding disk w/shaper

Analysis of variance was conducted at the 0.05 level.

Each test was examined at age 1 to record survival and seedling heights. Thereafter, the interval between examinations varied. All except the last study were measured at age 5, and four were also measured at age 10.

Treatment response was appraised on the basis of mean tree height. Diameter growth was not used because it is influenced by stand density, which varied in the studies.

RESULTS

Bedding reduced initial survival of loblolly pine significantly in two of five tests and of slash pine in one of six tests (table 2). Thorough flat disking reduced first year survival of slash pine significantly in one test; otherwise, it had little effect, good or bad. Combined results of all tests show that differences in survival between treatments were smaller at age 5 than age 1 and none were highly important.

Bedding improved height growth of slash pine significantly in four of the six tests (table 3). In those plantings that had reached age 10, mean heights for check plots were 17, 22, 28, and 32 feet; bedded plots were 0 to 2.4 feet taller than checks, and the difference was significant only on the two best sites. Bedding also caused a significant increase in both studies that were less

Table 2.—*Mean survival of slash and loblolly pine, by site treatment, at ages 1 and 5 years*

Study	Species	Survival at age 1			Survival at age 5[3]		
		Check	Disked	Bedded	Checked	Disked	Bedded
		Percent					
1	Slash	83	88	85	80	87	82
	Loblolly	96	95	84[1]	95	94	82
2	Slash	78	59	44	60	54	42
	Loblolly	87	93	58[1]	86	86	55
3	Slash	87	82	89	86	81	89
	Loblolly	74	88	90	74	88	90
4	Slash	91	83	83	91	83	83
	Loblolly	97	97	98	97	96	97
5	Slash	97	97	89	90	94	79
	Loblolly	98	98	95	90	91	82
6	Slash	87	78[1]	74[1]	[2]		
Combined studies[4]	Slash	87	81	77	81	80	75
	Loblolly	90	94	85	88	91	81

[1]Significantly different from the check at the 0.05 level.

[2]Double planting followed by removal of surplus seedlings precludes an estimate of survival after age 1.

[3]No statistical tests conducted for individual studies or combined studies as changes were generally small and largely due to fusiform rust.

Figure 2.—*Pulverized, shaped beds are 8 feet wide with crowns that are about 8 inches high.*

than 10 years old. On one, a poor site, bedding boosted average height at age 5 by 2.6 feet, the largest response recorded.

For loblolly pine, the merits of bedding are less convincing. In each of the five tests that included loblolly, bedded plots showed added height growth, but in only one test was the increase significant. In this study, flat disking was as effective as bedding. Loblolly is so sensitive to changes in site quality within a test location that variation among plots treated alike was high in every test. Consequently, statistical significance could not be shown even though differences in treatment mean heights were generally comparable to those recorded for slash pine.

Loblolly was clearly inferior to slash pine on the three poorest sites; on one judged to be intermediate, growth of the two species was alike through age 10; and on one good site height growth of loblolly was superior.

Cultural treatments, including site preparation, often are positively related to incidence of fusiform rust (*Cronartium fusiforme* Hunt ex. Cumm.) infection in a stand. General relationships are not easily established, however, because the disease is extremely variable from location to location, and often there are dramatic changes at one location in a relatively short time.

Bedded plots, with few exceptions, were more heavily infected than the checks, but differences in most cases were not large enough to be of concern (table 4). Most of the differences were in the range of 2 to 7 percentage points; the largest was 19 points, which occurred in loblolly pine at a location where 42 percent of the trees in the untreated check were infected.

Flat disking alone, by contrast, generally reduced rust incidence. All slash pine in five studies had less infection on disked plots than on the checks. For loblolly, differences were small in four tests, and disking increased infection by 9 percentage points in one.

Slash pine was clearly more vulnerable to fusiform rust than loblolly, but two studies demonstrated susceptibility of loblolly under severe conditions. In both studies, trees were heavily infected (40 to 60 percent at age 10), and differences between the two species were not great.

DISCUSSION

Six studies of bedding on poorly drained sites in southwest Louisiana have not provided con-

Table 3.—*Average total height of slash and loblolly pine trees by site treatment at ages 5 and 10 years*[1]

Study	Age	Slash pine			Loblolly pine		
		Site treatment			Site treatment		
		Check	Disked	Bedded	Check	Disked	Bedded
	Years	*Feet*					
1	5	10.3	11.6[2]	11.5[2]	9.4	10.2	10.5
	10	28.5	31.1[2]	30.5[2]	28.2	29.6	30.5
2	5	5.8	5.1	7.8	3.3	3.9	4.4
	10	17.3	17.6	18.5	8.5	11.1	9.7
3	5	12.2	12.1	14.0	11.6	12.9	13.2
	10	32.2	32.1	34.6[2]	34.8	37.3[2]	37.2[2]
4	5	6.7	5.8	7.1	3.7	4.2	5.0
	10	21.8	19.8	21.8	14.5	17.4	17.8
5	5	5.2	6.7[2]	7.8[2]	3.1	3.6	3.5
6	3	3.9	3.9	4.4[2]	—	—	—

[1]Study six measured at age 3.
[2]—differs significantly from the untreated check at the 0.05 level.

Table 4.—*Proportion of slash and loblolly pines with fusiform rust trunk cankers by site treatment at various ages*

Study	Age	Slash pine			Loblolly pine		
		Site treatment			Site treatment		
		Check	Disked	Bedded	Check	Disked	Bedded
	Years	*Percent*					
1	5	34	29	48	23	22	35
	10	49	39	55	46	44	45
2	10	15	13	15	8	8	6
3	8	43	39	50	9	8	11
4	5	10	6	10	25	1	4
	10	31	26	35	10	12	15
5	2[1]	3	4	8	2	6	11
	4[1]	48	45	53	42	51	61

[1]Trunk and branch infections combined.

clusive evidence that this intensive treatment is worth the extra cost. For slash pine — the species best adapted to wet soils — there was a significant boost in height growth in four of the six studies. However, the maximum response was 2.6 feet of added height at age 5. The difference did not increase with age. In 10-year-old plantings, the maximum difference in mean total height between bedded and check plots remained about 2 feet. It is still too early to determine if any of the early gains will diminish with stand age; however, such a reversal seems unlikely.

The main reward for bedding poorly drained soils in the West Gulf area apparently is a modest increase in early height growth. Any extra growth is desirable, and in some situations it may have value beyond the increase in volume. Established pine stands are said to "dry out" a wet site, and increased early growth would reduce the time interval before this "drying out" phase is reached.

There are corollary aspects of bedding to be considered. First is the problem of obtaining an adequate stand. Disking plus bedding reduces first-year competition considerably, and elevating the planting location on saturated soil should also improve survival. Yet this treatment increased first-year mortality in some plantings. Some poor results in early tests were attributed to rough, unsettled beds full of air pockets. Improved equipment makes a firmer bed; so survival should not be a problem if the soil is allowed to settle for 2 to 3 months before planting.

The second problem is fusiform rust. Our studies indicate that under conditions of low infection, bedding may increase disease incidence by 5 to 10 percentage points; where a stand is severely damaged, bedding may increase it as much as 50 percent. However, in neither case does the added infection have much economic significance, and in none of our tests were bedded plots heavily infected while checks remained relatively free of disease. Consequently, the fusiform rust hazard induced by bedding appears minimal.

The question of how to treat flat, waterlogged sites remains open. A firm recommendation for bedding cannot be made from the results of these six studies because gains in growth from this expensive treatment have been inconsistent and at best modest. A persistent problem has been variation within carefully selected and seemingly uniform study areas. Wider variation could be expected on an operational scale. Therefore, the only safe prediction is that response to bedding also will vary widely — often across small gradients in soil quality or wetness that are hard to distinguish.

Landowners should be highly selective in choosing sites to bed, restricting treatment to the wettest soils. Sites should be evaluated after winter rains are well underway, usually in January and early February. As a general rule, treat only those sites where the water table is at or near the surface for several consecutive weeks. Most important, orient beds to facilitate surface runoff by disking perpendicular to the contours. Depressions may require plowing a few outlet ditches.

Disked beds in continuous strips often aggravate surface drainage problems, even when they are carefully planned. The natural drainage system is often so poorly developed that bedding actually impounds water. Though the bed surface and the seedling are above water, the root zone

remains saturated when water is trapped between beds for prolonged periods. For this reason new studies are underway to test intermittent mounds 8 to 10 inches high pushed up with a bulldozer. Early indications are the growth on these so-called pimple mounds is considerably better than on the continuous elevated beds reported in this paper.

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Additional keywords: Mounding, ridging, disking, site preparation, height growth, *Pinus taeda, Pinus elliotti.*

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Tree Water Status Affects Induced Southern Pine Beetle Attack and Brood Production

PETER L. LORIO, JR. AND JOHN D. HODGES

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SUMMARY

Artificially induced moisture stress lowers loblolly pine resistance to attack by the southern pine beetle. The duration of oleoresin flow is curtailed and egg laying and larval development can progress rapidly.

Tests conducted from 1973 through 1975 involved artifically induced beetle attacks with limited populations. Even beetles that attacked first met little resistance in stressed trees.

Although beetles can successfully attack the healthiest loblolly pines, unstressed trees in the study resisted initial attack. Prolonged oleoresin flow entrapped or pitched out many beetles and delayed egg laying and larval development.

1977

Tree Water Status Affects Induced Southern Pine Beetle Attack and Brood Production

PETER L. LORIO, JR. AND JOHN D. HODGES

Observations by foresters and entomologists indicate that moisture stress increases a tree's susceptibility to attack by the southern pine beetle, *Dendroctonus frontalis* Zimm. (Thatcher 1960). Vite (1961) reported that bark beetle success is correlated with low oleoresin exudation pressure (OEP), and change in OEP is directly related to water stress in *Pinus ponderosa* Laws. With large loblolly pines (*Pinus taeda* L.), artificially induced moisture stress has marked effects on OEP and the relative water content of the inner bark (Lorio and Hodges 1968). The study reported here further examines the relationship between host tree physiology and the success of southern pine beetle (SPB) attack.

MATERIALS AND METHODS

Loblolly pines in natural stands were used for the study. First attempts at inducing beetle attacks were conducted in summer 1973 in the lower West Gulf Coastal Plain with sawtimber-size trees. The area had a native population of southern pine beetles.

Three pairs of trees were selected. Each pair had one prematurely declining and one apparently healthy tree. Following a method of T. L. Payne and J. E. Coster (personal communication), trees were rigged with 30-cm square hardware cloth traps coated with Stickem Special.®[1] Traps were placed at 0.6, 2.4, 4.2, and 6.0 m above ground level on one side of the tree and at 1.2, 3.0, and 4.8 m on the other side. A pulley system was used to lower traps for daily inspection and collection of beetles.

One pair of trees was used at a time. Loblolly pine bolts artificially infested with male-female pairs of beetles were used as attractants. These bolts were removed once a mass attack was established. When brood developed to the late larval or pupal stage, trees were felled and a 15-cm and a 30-cm bolt were taken between the 3.7 to 4.9 m levels. The longer bolts were placed in rearing cans so that emerging beetles could be counted. The shorter bolts were dissected and successful attacks counted. Emergence divided by 2 times the number of successful attacks provided an estimate of the ratio of increase of brood over successfully attacking adults (Thatcher and Pickard 1964).

To avoid large beetle populations, a second test (1973) was located on the upper West Gulf Coastal Plain in a dense loblolly pine stand that was apparently free of SPB. Trees averaged 20 cm in diameter at breast height (dbh) and 18 m in height. There was no evidence of declining trees. Moisture stress was induced in two trees by digging a narrow trench 1 m deep at a radius of 2 m around each tree. Trenches were lined with 6-mil polyethylene and refilled with soil. Shelters of exterior plywood covered with roofing felt were built around the trees and beyond the outer edge of the trenches to prevent soil water recharge. Two untreated study trees were used as controls.

In this test, attacks were induced with vials containing approximately 1 ml of synthetic attractant (Frontalure®) placed 4.3 m above ground on each tree. Attacking beetles came from naturally infested loblolly pines in the lower Coastal Plain. Approximately fifteen 60-cm bolts containing callow adults were placed around each tree. Sticky traps were used to assess attack patterns.

Two subsequent tests were established, one in 1974 and one in 1975. These tests were again conducted in an upper Coastal Plain area with no known SPB infestations. Three pairs of trees were used in 1974 and one pair in 1975. Moisture stress was induced in one tree in each pair and the other was used as a control. Trenches and shelters were constructed as before. Trees averaged 28 cm dbh and 15 m tall in 1974 and 30 cm dbh and 19 m tall in 1975.

[1]Trade names and company names are included to identify equipment and materials used and do not constitute endorsement by the USDA.

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Aluminum access tubes were installed to allow measurement of soil moisture with a neutron probe. Shelters were completed and soil moisture measurements begun by 17 May 1974 and 21 May 1975. Measurements were taken weekly with a modified Kaiser soil moisture probe (Model VMP 487) and a Troxler Scaler (Model 1651) 1 m from the bole and 25, 40, 55, 70, 85, 100, and 115 cm below the soil surface.

Sticky traps were not used in the 1974 or 1975 tests. Attacks were again induced with snythetic attractant and naturally infested bolts containing callow adults. When 15 to 25 attacks were observed near the attractant, vials and bolts were removed and the beetles destroyed to ensure a limited attack.

Bark samples were taken to assess attacks and brood development at 1.8, 3.6, and 5.5 m. One-tenth square foot samples were taken with an electric-powered hole saw from two sides of the tree 2 to 4 weeks after attack. Sampling varied according to our subjective judgement of attack progress.

Measurements of tree physiological status included OEP and oleoresin flow over a 24-hour period. OEP was measured as described by Hodges and Lorio (1968). Xylem water potential of twigs was estimated on three trees in August 1974 when it was evident that a wide difference in the water status of trees existed. The pressure-chamber method of Scholander *et al.* (1975) was used.

RESULTS

1973 Tests: The first test compared declining trees with apparently healthy trees in the lower Coastal Plain. The attraction technique was successful and the trapping technique gave an adequate indication of the time and number of beetles attacking and of attack height. Between-tree tests were inconclusive, however, because beetle population was high; all trees, declining and healthy, were readily overcome. Approximately equal numbers of males and females were trapped at all heights (table 1). Early-attacking beetles were most numerous near the attractant bolts, about 4.2 m high. Bolt removal did not seem to influence subsequent attacks.

In the second test (upper Coastal Plain) the beetle population was limited to infested bolts placed around each test tree but was large enough that all trees, stressed or untreated, were successfully attacked. Trees were smaller than in the first test and beetles were able to produce brood with comparable ratios of increase (table 1). Turpentine beetles (*D. terebrans* [Oliv.]) also attacked the test trees and neighboring trees. An adjacent area had been clearcut earlier and turpentine beetles had developed high populations in the stumps.

1974 Tests: Results demonstrate that stressed trees can be overcome by SPB more easily than unstressed trees (table 2). Attacks were induced on the first pair of trees (1A and 1B) on 10 July 1974 and maximum OEP in these trees differed by 1 bar (5.2 vs 6.2). Available soil moisture had been virtually depleted under 1A for about 3 weeks. Tree 1B had slightly more water available on 10 July and considerably more during the pre-

Table 1. *Numbers of beetles trapped and emergence of brood from pairs of study trees (1973).*

Location		Tree pairs	Beetles trapped			Emergence per square meter[1]	Ratio of increase[2]
			Male	Female	Total		
Lower Coastal Plain	1	Declining	2099	2013	4112	8866	9.32
		Healthy	1331	1305	2636	3691	3.91
	2	Declining	1955	1945	3900	3476	3.23
		Healthy	1592	1591	3183	5509	5.78
Upper Coastal Plain	3	Stressed	482	381	863	6682	6.73
		Control	270	239	509	2561	3.58
	4	Stressed	653	674	1327	2023	4.04
		Control	383	485	868	2755	4.27

[1] 10.76 x attacks per ft².

[2] Ratio of emerging beetles to a count of successful attacks multiplied by 2.

Table 2. *Evaluation of attacks and dates attacks were induced, bark sampled, trees cut, and bolts taken for emergence samples.*

Tree	Treatment	Attacks induced	Bark sampled	Trees cut and bolts sampled	Initial attacks	Tree response
			1974 dates			
1A	Stressed	July 10	Aug. 7	Aug. 19	Successful	Killed by initial attacks
1B	Control	July 10	Aug. 7	Aug. 28	Unsuccessful	Succumbed after further attack
2A	Stressed	[1]	Aug. 19	Aug. 28	Successful	Killed by initial attacks
2B	Control	Sept. 4	Sept. 19	not cut	Unsuccessful	Still surviving
3A	Stressed	Sept. 4	Sept. 19	Oct. 17	Successful	Killed by initial attacks
3B	Control	Sept. 4	Sept. 19	Nov. 1	Unsuccessful	Succumbed after further attack
			1975 dates			
4A	Stressed	July 25	Aug. 8	Sept. 3	Successful	Killed by initial attacks
4B	Control	July 25	Aug. 8	Sept. 17	Successful	Killed by initial attacks

[1] Attacks apparently initiated by parent adults that emerged from 1A.

ceding weeks (fig. 1). Prolonged periods of no or very slow moisture depletion indicate little or no readily available water in the zone measured. Rate and quantity of water depletion depends on the intensity of tree rooting as well as on soil characteristics and atmospheric conditions.

Trees 2B, 3A, and 3B were subjected to attack on 4 September; 3A had been without significant available water since mid-June and 2B and 3B were experiencing moisture stress (fig. 1). Maximum OEP values for 2B, 3B, and 3A at that time were 7.5, 6.5, and 6.2 bars. Resin flow measurements of 20 August showed the same trend: 8.4, 5.6, and 1.6 ml. Measurements on 7 May, prior to natural or artificially induced moisture stress, yielded 8.0, 5.2, and 5.8 ml.

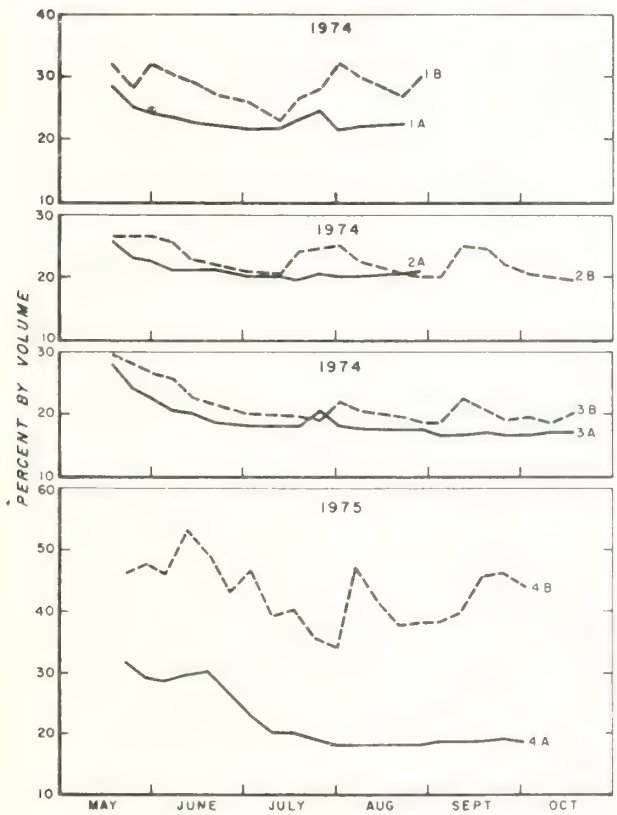

Figure 1. *Soil moisture changes under artificially stressed (solid line) and control trees (dotted line) in 1974 and 1975.*

It was apparent from periodic examination of individual attacks and from bark samples that even the beetles that attacked first met very little resistance in stressed trees (table 3). Pitch tubes were small, gallery formation and egg laying began almost immediately, and the brood reached pupal stage in about one month. Tree 2A seemed especially susceptible to attack. Unlike 1A and 3A in which attack was artificially induced, tree 2A was attacked naturally, apparently by parent adult beetles that emerged from 1A. Tree 2A was under extreme moisture stress to the extent that the crown had begun to fade and SPB attacks did not produce pitch tubes. Although the SPB apparently attacked first, large numbers of *Ips avulsus* and *I. calligraphus* also attacked the tree, especially near the 5.5 m level.

Of control trees, 2B successfully resisted all SPB attacks. No brood were produced and most attacking beetles were "pitched out" at the time bark samples were taken (table 3). The tree was also able to resist numerous black turpentine beetle attacks. SPB pitch tubes were very large compared with those on artificially stressed trees. Control trees 1B and 3B also resisted initial controlled attack but succumbed to later attacks by the SPB and *Ips* species. Observation of individual attack points and bark samples indicated that initial attacks were not successful. About one month after attack the inner bark was still wet, there were no visible signs of discoloration,

Table 3. *Status of induced SPB attacks based on bark samples and bolts cut in 1974.*

Treatment	Tree No.	Sample Height	Bark samples: Parent Adults Live	Parent Adults Dead	Larval Mines	SPB Attacks S[1]	SPB Attacks U	SPB Attacks T	Pitched Out	Dead in Gallery	Emergence from Sample Bolts
		Meters	Number per square foot [2]								
Stressed	1A	1.8	0	10	510	35	20	55	20	0	80
		3.6	0	5	500	30	5	35	5	0	51
		5.5	0	5	500	30	10	40	10	0	131
Control	1B	1.8	15	25	0	10	40	50	35	5	51
		3.6	25	45	10	15	45	60	40	5	10
		5.5	0	5	0	0	10	10	10	0	1
Stressed	2A	1.8	0	0	200	30	0	30	0	0	26
		3.6	0	0	240	40	0	40	0	0	7
		5.5	0	0	95	15	5	20	5	0	---[3]
Control	2B	1.8	0	0	0	0	15	15	15	0	0
		3.6	0	0	0	5	35	40	25	10	0
		5.5	0	0	0	5	20	25	10	10	0
Stressed	3A	1.8	55	0	230	30	0	30	0	0	214
		3.6	35	0	945	40	0	40	0	0	255
		5.5	35	0	550	35	0	35	0	0	244
Control	3B	1.8	35	0	0	20	25	45	15	10	277
		3.6	50	10	0	20	35	55	25	10	5
		5.5	55	0	0	25	20	45	20	0	1

[1] S = successful; U = unsuccessful; T = total.
[2] Multiply by 10.76 to obtain metric equivalent.
[3] No sample bolt cut; high number of *Ips* attacks and some apparent emergence.

and no larval mines were detected. However, attacks by *IPS* species and new attacks by SPB were observed. Initial beetle attacks apparently decreased resistance to subsequent attacks, but the beetles still had difficulty establishing galleries because of oleoresin flow. Two months after initial attack SPB larvae and pupae were observed.

Beetle emergence from control trees 1B and 3B was much less than from stressed trees 1A and 3A (table 3). This indicates that conditions for egg laying and brood development were not as favorable in unstressed trees.

1975 Tests: On 24 July, measurements of OEP and oleoresin flow on 4B (control) and 4A (stressed) revealed that maximum OEP was 9.6 bars in 4B and 7.9 bars in 4A. Oleoresin flow had respective figures of 5.2 and 28.4 ml. SPB attacks were induced on 25 July. At that time the stressed tree had depleted most available water in the soil and the control tree had an abundance of water (fig. 1).

For both stressed and control trees the number of induced attacks were sufficient to overcome the tree (table 4). Tree 4B apparently had a low resistance to attack regardless of water status. Recent research at Mississippi State University indicates that tree susceptibility can be predicted on the basis of oleoresin flow and other physical properties of the oleoresin system (Hodges, et al., in press). Under their system tree 4B would have been classified as highly susceptible to beetle attack. Tree 4A, previous to induced moisture stress, would have been expected to show much more resistance to attack than 4B.

DISCUSSION

First evaluations of induced SPB attacks in declining and apparently healthy trees indicated that even the most healthy loblolly pine will succumb to attack by a large SPB population. By limiting the supply of attacking beetles it was possible to demonstrate differences in resistance to attack as well as in brood production. How-

Table 4. *Status of induced SPB attacks based on bark samples and bolts cut in 1975.*

Treatment	Tree No.	Sample Height	Bark samples: Parent Adults Live	Parent Adults Dead	Larval Mines	SPB Attacks S[1]	SPB Attacks U	SPB Attacks T	Pitched Out	Dead in Gallery	Emergence from Sample Bolts
		Meters	Number per square foot[2]								
Stressed	4A	1.8	0	0	0	30	10	40	0	10	121
		3.6	0	0	5	30	20	50	10	10	143
		5.5	0	0	150	40	20	60	10	10	56
Control	4B	1.8	0	0	0	20	0	20	0	0	139
		3.6	0	0	0	30	10	40	0	10	32
		5.5	0	0	0	30	10	40	10	0	0

[1] S = successful; U = unsuccessful; T = total.
[2] Multiply by 10.76 to obtain metric equivalent.

ever, difficulties in selecting uniform study trees, handling beetle populations, inducing attacks, sampling bark at the correct time, rearing brood from cut bolts, and obtaining sufficient replications for analysis of variance preclude standard analysis and completely objective interpretation of results.

Several meaningful points can be made from the tests with limited SPB populations and host trees under various degrees of moisture stress. Trees under severe moisture stress (1A, 2A, 3A and 4A) have almost no resistance to attacking beetles. Although trees may yield abundant resin from a standard wound, duration of oleoresin flow is curtailed by moisture stress, and egg laying and larval development progress rapidly. Better hydrated trees hinder beetle attack primarily through oleoresin flow into the galleries. This prevents effective egg laying and larval development. Some beetles are trapped in the galleries, others are pitched out, and all must expend an unusual amount of energy.

Figures 2a and 2b illustrate the differences found between stressed and control trees at the time bark samples were taken about 2 weeks after inducing attack and when trees were felled for rearing brood (40 to 49 days after attack).

Severely stressed trees may produce a primary attractant to SPB. Beetles that attacked 2A had to bypass several non-study trees. Tree 2A produced no pitch tubes; radial growth was nil and the tree was near death at the time of attack. Such trees are perhaps similar to severely declining pines that have been observed repeatedly with SPB attacks in the mid bole. Growth has practically ceased and the oleoresin supply is negligible in such trees. If pitch tubes are produced, they are very minute.

Figure 2a. *Exposed xylem two weeks after induced attack. Stressed tree has egg gallery etchings and blue stain; control tree has abundant oleoresin accumulation.*

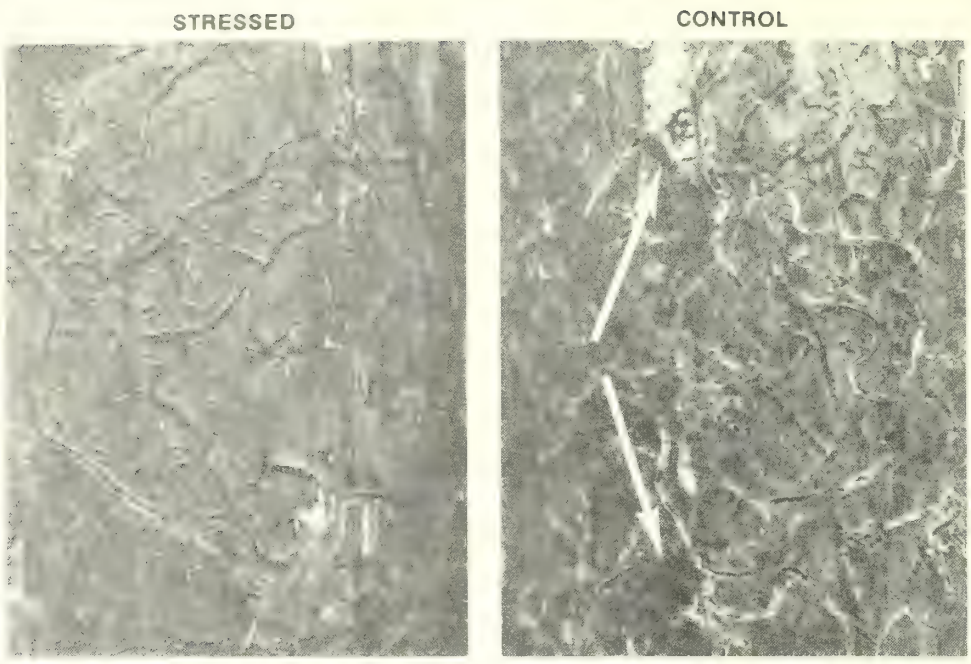

Figure 2b. *Good brood development in stressed tree with little or no oleoresin in egg galleries 40 days after induced attack. Poor brood development in untreated tree with pitch-soaked areas and oleoresin in egg galleries (note arrows) 49 days after attack.*

Trees with a moderately good water status and oleoresin supply (2B) can successfully repel a considerable SPB attack. Also, the blue stain fungus, *Ceratocystis minor,* is apparently occluded from the xylem. Pines in well-managed stands on good sites with an adequate water supply to maintain large crowns and good growth are most likely to have these oleoresin and water status characteristics.

High oleoresin flow (4A) will not necessarily deter a moderate SPB attack if an acute moisture deficit exists. Flow depends partially on the water status of the living epithelial cells surrounding the resin ducts. Internal moisture stress reduces the pressure exerted by these cells on the oleoresin, and the rate and duration of flow are curtailed.

There are various degrees of resistance to attack. Environmental conditions influence both host resistance and SPB behavior. To the extent that the environment can be manipulated, such as by thinnings and sanitation cuts, the probability of successful attacks can be reduced.

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